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IDENTIFIERS	DACUM Process

ABSTRACT

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 1-year vocational training program to prepare students for entry-level employment as industrial maintenance technicians. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with 19 duties (and supporting technical workplace competencies): practice safety; apply mathematical concepts; interpret engineering drawings and control documents; use measuring tools; use hand tools; operate machine tools; perform welding operations; maintain/troubleshoot equipment and systems; repair power transmission systems; fabricate/install sheet metal parts; piping operations; basic rigging; bearing maintenance; use computers; align shafts; install/align machines; maintain electrical devices; basic mechanical concepts; and fasteners and preloading. The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The two-volume instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment

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with answer key. The handbook is arranged by duty grouping, with technical modules developed for each task box on the competency profile. The student laboratory manual contains a DACUM chart and learning modules. Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (YLB)

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ED 422 487

Industrial Maintenance Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor's Handbook
Student Laboratory Manual

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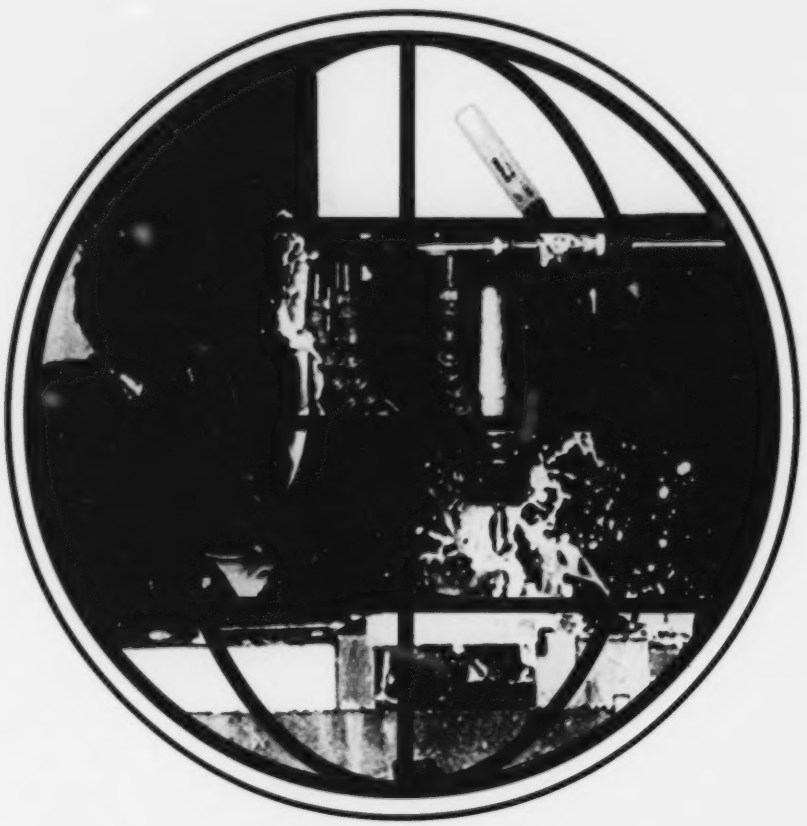
MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY



Industrial Maintenance Series

COURSE SYLLABI

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Supported by the National Science Foundation's Advanced Technological Education Program

MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Industrial Maintenance Series

COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

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National Science Foundation
Advanced Technological
Education Program

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National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
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Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, AUGUSTA, GA
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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction

MASTER research indicates that a minimum of one year of occupational study and training will prepare students with the entry-level skills necessary for the industrial maintenance trade. These findings led us to structure our pilot program to a one-year schedule.

In this one-year program, the students progress through a series of industrial maintenance courses designed to both educate and train students with knowledge and skills in areas ranging from industrial mechanics and refrigeration fundamentals to an introduction to microcomputer operations and electrical systems. Students receive a wide range of training which enables them to seek jobs in many different areas. The Industrial Maintenance Program at Augusta Technical Institute (ATI) has been training Industrial Maintenance Mechanics for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive certificates of completion from ATI. The Industrial Maintenance Department worked closely with the MASTER staff, made every effort to assist the MASTER staff with research, and currently seek adoption of the recommended MASTER materials for their Industrial Maintenance students. The Industrial Maintenance Department at ATI is recognized throughout Georgia by large and small manufacturing companies as a premier source for entry-level technicians. Upon graduation, students are able to understand general operation of all machines, mechanical or electrical, conventional or computer controlled, that contribute to the manufacturing process. The curriculum has been designed to prepare students to enter the workforce as entry-level Industrial Maintenance Mechanics. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Industrial Maintenance department has a unique blend of theoretical knowledge and practical application which directly corresponds to modern uses in industrial maintenance.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine-related occupations (specifically industrial maintenance), the **MASTER** Consortium Partners have agreed to present our definition of an industrial maintenance mechanic as follows:

INDUSTRIAL MAINTENANCE MECHANIC - uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become industrial maintenance mechanics.

The first and most important task of the **MASTER** program was the development of a foundation upon which all other works could be built. The **MASTER** Competency Profile is this foundation.

The MASTER Competency Profile

Development of Competency Profiles at each of the **MASTER** sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, the **MASTER** staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document over which they could claim ownership. This, in effect, made them real partners in the work of **MASTER**.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Industrial Maintenance, as shown on the following page.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The **MASTER** Competency Profile for Industrial Maintenance Mechanic has been included on the following page.

Industrial Maintenance Mechanic Competency Profile

Job Analysis conducted and prepared by

MASTER

***M**achine Tool **A**dvanced **S**kills*
***T**echnology **E**ducational*
***R**esources Program*
Consortium

Industrial Maintenance Mechanic

Technical Workplace Competencies

Duties	Tasks			
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety
	A-5 Lifting safety	A-6 Lockout/tagout		
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations
	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations		
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions	
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools		
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools		
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder
	F-5 Operate lathes	F-6 Use and care of drill presses		

Industrial Maintenance Mechanic

Technical Workplace Competencies

Duties	Tasks			
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering	
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps
	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems
	H-9 Troubleshoot, maintain, and repair pneumatic systems			
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches
J Fabricate/Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together	
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support
	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe	
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills		

Industrial Maintenance Mechanic

Technical Workplace Competencies

Duties	Tasks			
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings		
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations		
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment		
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors
	Q-5 Troubleshoot electrical devices			
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines
	R-5 Power			
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners

Industrial Maintenance Mechanic

Technical Workplace Competencies

Duties		Tasks			
S	**Fasteners and Preloading (continued)**	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique	

Industrial Maintenance Mechanic

Skills, Traits and Trends

Skills and Knowledge

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

Traits and Attitudes

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientiousness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

Tool/Equipment Proficiency

Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.)
Measuring Tools
Power Tools
Drill Presses
Power Saws
Power Drills
Hydraulic Presses
Welding Equipment (SMAW, GMAW)
Alignment/Calibration Tools
Computer
Personal Safety Equipment
Oxyacetylene Equipment
Vises
Pedestal Grinders
Pipe Threading Dies
Pipe/Conduit Bending Equipment
AC Service Equipment
Power Transmission Devices
Hydraulic Training Equipment
Electrical Testing Equipment
Air Compressor
Air Powered Tools
Rigging Equipment

Current Trends

Statistical Process Control
Composites
Laser Alignment
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
More Sophisticated Computer Controls
Hazardous Materials Handling

The MASTER Pilot Program
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each **MASTER** partner reviewed its existing curriculum against the industry–verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the **MASTER** grant proposal:

> ***Pilot Program***: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."
>
> ***Student Assessment***: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry–level and already–employed technicians."
>
> (***Note***: Not all occupational specialty areas were pilot–tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.

MASTER Curriculum
INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 103	Algebraic Concepts	5	0	5
ELC 106	Direct Current Circuits I	3	2	4
IMM 101	Industrial Maintenance Safety Procedures	2	1	2
IMM 108	Industrial Mechanics I	5	5	7
CMP 101	Introduction to Microcomputers	1	4	3
		16	12	21
SECOND QUARTER*				
ENGL 101	English	5	0	5
ELC 109	Alternating Current I	3	2	4
ELC 110	Alternating Current II	3	2	4
IMM 128	Pumps & Piping Systems	1	4	2
IMM 113	Industrial Hydraulics	6	4	8
		18	12	23
THIRD QUARTER*				
PSY 100	Interpersonal Relations and Professional Development	3	0	3
IMM 110	Industrial Mechanics II	3	7	6
IMM 115	Industrial Pneumatics	3	2	4
IMM 100	Refrigeration Fundamentals	3	2	4
XXX ###	Elective	-	-	3
		12	11	20
FOURTH QUARTER*				
WLD 133	Metal Welding and Cutting Techniques	2	3	3
IMM 109	Lathe Operations I	4	6	7
IMM 133	Industrial Maintenance-Mechanical Review	1	4	3
XXX ###	Elective	-	-	3
		7	13	16

***Each quarter is 10 weeks in length.**

MASTER Course Descriptions

Industrial Maintenance Technology

(One Year Diploma/Advanced Certificate Program)

First Quarter

MATH 103 **Algebraic Concepts** (5-0-5) Introduces concepts and operations which can be applied to the study of algebra. Topics include: use of variables, manipulation of algebraic expressions, solution of linear and quadratic equations, evaluation and graphing of linear and quadratic functions, and solution of systems of linear equations. Class includes lecture, applications, and homework to reinforce learning. (Prerequisite: MATH 098, Pre-Algebra, or entrance math score)

ELC 106 **Direct Current Circuits I** (3-2-4) Introduces direct current (DC) concepts and applications. Topics include: fundamental electrical principles and laws; direct current test equipment; series, parallel, and combination circuits; and basic laboratory procedures and safety practices. (Prerequisites: MATH 103, Algebraic Concepts)

IMM 101 **Industrial Maintenance Safety Procedures** (2-1-2) Provides an in–depth study of the health and safety practices required for maintaining industrial production equipment. Topics include: traffic safety, ladder safety, fire safety, safe work in confined spaces, electrical safety, emergency procedures, an introduction to OSHA regulations,. MSDS Right–To–Know Law, hazardous materials safety, and safety equipment.

IMM 108 **Industrial Mechanics I** (5-5-7) Provides instruction in those basic physics concepts which are applicable to mechanics of industrial production equipment; teaches basic industrial application of mechanical principles with emphasis on power transmission and specific mechanical components. Topics include: mechanical tools, fasteners, basic mechanics, lubrication, bearings, and packings and seals.

CMP 101 **Introduction to Microcomputers** (1-4-3) Introduces fundamental concepts and operations necessary to utilize microcomputers. Emphasis is placed on basic functions and familiarity with computer use. Topics include: computer terminology; computer operating systems; data storage; file management; equipment care and operation; and an introduction to work processing, database, and spreadsheet application. (Prerequisite: Provisional admission)

Second Quarter

ENGL 101 **English** (5-0-5) Emphasizes the development and improvement of written and oral communication abilities. Topics include: analysis of writing techniques used in selected readings, writing practice, editing and proofreading, research skills, and oral presentation skills. Homework assignments reinforce classroom learning. (Prerequisite: ENGL 097, English III and RAG 097, Reading III, or the equivalent)

ELC 109 **Alternating Current I** (3-2-4) Introduces the theory and application of varying sine wave voltages and current. Topics include: AC wave generation, oscilloscope operation, inductance, and capacitance. (Prerequisites/Corequisite: ELC 108, Direct Current Circuits, II, MATH 104, Geometry and Trigonometry, or MATH 105, Trigonometry)

ELC 110 **Alternating Current II** (3-2-4) Continues development of AC concepts with emphasis on constructing, verifying, and troubleshooting reactive circuits using RLC theory and oscilloscopes. Topics include: simple RLC circuits, AC circuit resonance, passive filters, transformer theory and applications, and non-sinusoidal wave forms. (Prerequisite/Corequisite: ELC 109, Alternating Current II)

IMM 128 **Pumps and Piping Systems** (1-4-2) Provides instruction in the operation of industrial pumps, valves, and piping/delivery systems with emphasis on installation procedures, maintenance and repair. Topics include: pump identification, pump operation, pump installation, maintenance, troubleshooting, piping systems, and installation and repair of piping systems.

IMM 113 **Industrial Hydraulics** (6-4-8) Provides instruction in fundamental concepts and theories for the safe operation of hydraulic components and systems. Topics include: hydraulic theory, suction side of pumps, actuators, valves, pumps/motors, accumulators, symbols and circuitry, types of fluids, filters, servicing safety, preventative maintenance, and troubleshooting.

Third Quarter

PSY 100 **Interpersonal Relations and Professional Development** (3-0-3) Provides a study of human relations and professional development in today's rapidly changing world to prepare students for living and working in a complex society. Topics include: personal skills required for an understanding of self and others; projecting a professional image; job acquisition skills such as conducting a job search, interviewing techniques, job applications, and resume preparation; and desirable job performance skills and attitudes necessary for job retention and advancement. (Prerequisite: Provisional admission)

IMM 110 **Industrial Mechanics II** (3-7-6) Continues the application of mechanical principles to industrial production equipment with emphasis on power transmission and mechanical components. Emphasis is placed on alignment and tension. Topics include: mechanical drive systems, couplings and alignment, clutches and brakes, linkage and levers, mechanical troubleshooting, and preventative maintenance.

IMM 115 **Industrial Pneumatics** (3-2-4) Provides instruction in fundamental concepts and theories for the safe operation of pneumatic components and systems. Topics include: pneumatic theory, preventative maintenance, compressors, regulators, pneumatic valves, actuators, servicing safety, and troubleshooting.

IMM 100 **Refrigeration Fundamentals** (3-2-4) Introduces basic concepts and theories of refrigeration. Topics include: the laws of thermodynamics, pressure and temperature relationships, heat transfer, the refrigeration cycle, and safety.

Fourth Quarter

WLD 133 **Metal Welding and Cutting Techniques** (2-3-3) Provides instruction in the fundamental use of the electric arc welder and the oxyacetylene cutting outfit. Emphasis is placed on safe setup and use of equipment. Topics include: safety practices, arc welding equipment and setup, oxyfuel welding, flame cutting equipment and setup, and welding and cutting procedures. (Prerequisite: Provisional admission)

IMM 109 **Lathe Operations I** (4-6-7) Provides opportunities for students to develop skill in the use of bench grinders and lathes. Topics include: lathes, bench grinders, bench grinder operations, lathe calculations, lathe setup, and lathe operations. (Prerequisite: Provisional admission)

IMM 133 **Industrial Maintenance–Mechanical Review** (1-4-3) Summarizes and integrates all previous CMP, ELC, and IMM courses to assist Industrial Maintenance Technology students in assembly, troubleshooting, and repair of multi–system machinery and devices. Topics include: electrical, mechanical, and fluidic interfacing in complex and industrial equipment.

The MASTER
Technical Workplace Competencies
and
Course Crosswalk

After development of appropriate curricula for the pilot programs, each **MASTER** college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry-level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks and the pilot curriculum for Industrial Maintenance. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

EXIT PROFICIENCY LEVEL SCALE					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	Rarely	Routinely with Supervision	Routinely with Limited Supervision	Routinely Without Supervision	Initiates/ Improves/ Modifies and Supervises Others

Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry–level employees have been incorporated into the development of the course syllabi.

INDUSTRIAL MAINTENANCE TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Algebraic Concepts	Direct Current Circuits I	Indus. Maint. Safety Pro.	Industrial Mechanics I	Intro to Microcomputers	Alternating Current I	Alternating Current II	Pumps & Piping Systems	Industrial Hydraulics	Industrial Mechanics II	Industrial Pneumatics	Refrigeration Fundamentals	Metal Welding/Cutting Tech.	Lathe Operations I	Industrial Maint.-Mech. Review						EXIT PROFICIENCY LEVEL
A. PRACTICE SAFETY																					
A-1 Use Protective Equipment		I	M	I		R	R	R	R	R	R	R	R	R	M						4
A-2 Accident Prevention		I	R	I		R	R	R	R	R	R	R	R	R	R						3
A-3 Working Aloft		I	I	I		R	R	R	R	R	R	R	R	R	R						2
A-4 Fire Safety		I	R	I		R	R	R	R	R	R	R	R	R	R						2
A-5 Lifting Safety		I	R	I		R	R	R	R	R	R	R	R	R	R						3
A-6 Lockout/Tagout		I	M	I		R	R	R	R	R	R	R	R	R	M						4
B. APPLY MATHEMATICAL CONCEPTS																					
B-1 Perform Basic Arithmetic Functions	I	I		I		R	R	R	R	R	R	R	R	R	M						4
B-2 Convert Fractions/Decimals	I	I		I		R	R	R	R	R	R	R	R	R	R						3
B-3 Convert Metric/English Measurements		I		I		R	R	R	R	R	R	R		R	R						3
B-4 Perform Basic Algebraic Operations	M	I				R	R		R			R	R	R	R						3
B-5 Perform Basic Trigonometry Functions													I	I	I						2
B-6 Perform Basic Geometric Calculations													I	I	I						2
C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS																					
C-1 Identify Basic Types of Drawings				I		I	R		R	R	R	R	R	R	M						4
C-2 Identify Basic Layout of Drawings				I		I	R		R	R	R	R	R	R	R						3
C-3 Review Blueprint Notes and Dimensions				I		I	R		R	R	R	R	R	R	R						3
D. USE MEASURING TOOLS																					
D-1 Use Non-Precision Measuring Tools				I					R	R	R	R	R	R	M						4
D-2 Use Precision Measuring Tools										I				R	R						3
E. USE HAND TOOLS																					
E-1 Identify and Use Maintenance Technician's Hand Tools		I		I		R	R	R	R	R	R	R	R	R	M						4
E-2 Identify and Use Hand Held Power Tools		I		I		R	R	R	R	R	R	R	R	R	R						3

I=Introduced and Taught R=Repeated and Reinforced M=Mastered

INDUSTRIAL MAINTENANCE TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Algebraic Concepts	Direct Current Circuits I	Indus. Maint. Safety Pro.	Industrial Mechanics I	Intro to Microcomputers	Alternating Current I	Alternating Current II	Pumps & Piping Systems	Industrial Hydraulics	Industrial Mechanics II	Industrial Pneumatics	Refrigeration Fundamentals	Metal Welding/Cutting Tech.	Lathe Operations I	Industrial Maint.-Mech. Review						
F. OPERATE MACHINE TOOLS																					
F-1 Use and Care of Milling Machines														I	R						3
F-2 Use and Care of Horizontal and Vertical Band Saws														I	R						3
F-3 Use and Care of Pedestal Grinder														I	R						3
F-4 Use and Care of Surface Grinder														I	R						3
F-5 Operate Lathes														I	R						3
F-6 Use and Care of Drill Presses														I	R						3
G. PERFORM WELDING OPERATIONS																					
G-1 Weld With Shielded Metal Arc Welding (SMAW) Process													I		R						3
G-2 Weld/Cut With Oxyacetylene													I		R						3
G-3 Perform Gas Soldering													I		R						3
H. MAINTAIN/TROUBLESHOOT EQUIPMENT AND SYSTEMS																					
H-1 Maintain Air Conditioning Systems												I			R						3
H-2 Maintain Pneumatic Control Circuits								I			R				R						3
H-3 Troubleshoot Centrifugal Pumps								I	R			R			R						3
H-4 Troubleshoot Positive Displacement Pumps								I	R			R			R						3
H-5 Maintain Gate, Globe, Ball, Plug, and Butterfly Valves								I	R		R	R			R						3
H-6 Maintain Check Valves and Relief Valves								I	R		R	R			M						4
H-7 Troubleshoot and Repair Blowers							I		R	R		R			R						3
H-8 Troubleshoot, Maintain, and Repair Hydraulic Systems								I	R			R			R						3
H-9 Troubleshoot, Maintain, and Repair Pneumatic Systems								I			R				R						3
I. REPAIR POWER TRANSMISSION SYSTEMS																					
I-1 Maintain and Troubleshoot Belt Drive Systems				I						R					M						4
I-2 Maintain and Troubleshoot Gear Power Transmission Drives				I						R					M						4
I-3 Maintain and Troubleshoot Chain Power Transmission Drives				I						R					M						4
I-4 Maintain and Troubleshoot Clutches				I						R					R						3

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Page 1

INDUSTRIAL MAINTENANCE TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Algebraic Concepts	Direct Current Circuits I	Indus. Maint. Safety Pro.	Industrial Mechanics I	Intro to Microcomputers	Alternating Current I	Alternating Current II	Pumps & Piping Systems	Industrial Hydraulics	Industrial Mechanics II	Industrial Pneumatics	Refrigeration Fundamentals	Metal Welding/Cutting Tech.	Lathe Operations I	Industrial Maint. Mech. Review					EXIT PROFICIENCY LEVEL
J. FABRICATE/INSTALL SHEET METAL PARTS																				
J-1 Layout Sheet Metal Parts												I			R					3
J-2 Form and/or Bend Sheet Metal Parts												I			R					3
J-3 Fasten Sheet Metal Parts Together												I			R					3
K. PIPING OPERATIONS																				
K-1 Perform Basic Pipefitting Calculations				I				R		R					M					4
K-2 Cut, Thread, and Ream Pipe				I				R		R					M					4
K-3 Pipe Assembly				I				R		R					M					4
K-4 Install and Adjust Pipe Support				I				R		R					M					4
K-5 Tubing				I				R		R					M					4
K-6 Fittings				I				R		R					M					4
K-7 Plastic Pipe				I				R		R					M					4
L. BASIC RIGGING																				
L-1 Rigging Fundamentals				I						R					M					4
L-2 Demonstrate Basic Rigging Skills				I						R					M					4
M. BEARING MAINTENANCE																				
M-1 Plain Bearings				I				R	R	R					M					4
M-2 Rolling Element Bearings				I				R	R	R					M					4
N. USE COMPUTERS																				
N-1 Perform Basic Word Processing					I										R					2
N-2 Perform Basic Spreadsheet Operations					I										R					2
O. ALIGN SHAFTS																				
O-1 Principles of Alignment				I					R	R					M					4
O-2 Methods of Alignment				I					R	R					M					4

D:\MX\WALK.PM6-CD\4/8

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INDUSTRIAL MAINTENANCE TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Algebraic Concepts	Direct Current Circuits I	Indus. Maint. Safety Pro.	Industrial Mechanics I	Intro to Microcomputers	Alternating Current I	Alternating Current II	Pumps & Piping Systems	Industrial Hydraulics	Industrial Mechanics II	Industrial Pneumatics	Refrigeration Fundamentals	Metal Welding/Cutting Tech.	Lathe Operations I	Industrial Maint.-Mech. Review							
P. INSTALL/ALIGN MACHINES																						
P-1 Install Electrical Connections		I				R	R					R			R							3
P-2 Setting and Leveling				I						R					R							2
P-3 Grouting								I							R							2
P-4 Special Mountings				I				R	R	R					R							2
Q. MAINTAIN ELECTRICAL DEVICES																						
Q-1 Use Electrical Test Equipment		I				R	R					R			M							4
Q-2 Apply Basic Terms to Electrical Circuits		I				R	R					R			R							3
Q-3 Analyze Series, Parallel, and Complex AC/DC Circuits		I				R	R					R			R							3
Q-4 Check AC and DC Motors		I				R	R					R			R							3
Q-5 Troubleshoot Electrical Devices		I				R	R					R			R							3
R. BASIC MECHANICAL CONCEPTS																						
R-1 Force				I						R					M							4
R-2 Work				I						R					M							4
R-3 Mechanical Motion and Rate				I						R					R							3
R-4 Simple Machines				I						R					R							3
R-5 Power				I						R					M							4
S. FASTENERS AND PRELOADING																						
S-1 Fasteners and Nomenclature										I					R							3
S-2 Application for Various Fasteners										I					R							3
S-3 Techniques for Removing Damaged Fasteners										I					R							3
S-4 Cleaning and Restoring Threaded Fasteners										I					R							3
S-5 Torque/Preload Theory										I					R							3
S-6 Effects of Lubricating Threads Prior to Torquing										I					R							3
S-7 Demonstrate Appropriate Torquing Technique										I					R							3

I=Introduced and Taught R=Repeated and Reinforced M=Mastered

SCANS

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three–part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	*Identifies, organizes, plans, and allocates resources*
Interpersonal:	*Works with others*
Information:	*Acquires and uses information*
Systems:	*Understands complex inter-relationships*
Technology:	*Works with a variety of technologies*

FOUNDATION SKILLS:

Basic Skills:	*Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well*
Thinking Skills:	*Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*
Personal Qualities:	*Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty*

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, **MASTER** asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. **MASTER** also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the **MASTER** staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. **MASTER** realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

MASTER Curriculum
INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 103	Algebraic Concepts	5	0	5
ELC 106	Direct Current Circuits I	3	2	4
IMM 101	Industrial Maintenance Safety Procedures	2	1	2
IMM 108	Industrial Mechanics I	5	5	7
CMP 101	Introduction to Microcomputers	1	4	3
		16	12	21
SECOND QUARTER*				
ENGL 101	English	5	0	5
ELC 109	Alternating Current I	3	2	4
ELC 110	Alternating Current II	3	2	4
IMM 128	Pumps & Piping Systems	1	4	2
IMM 113	Industrial Hydraulics	6	4	8
		18	12	23
THIRD QUARTER*				
PSY 100	Interpersonal Relations and Professional Development	3	0	3
IMM 110	Industrial Mechanics II	3	7	6
IMM 115	Industrial Pneumatics	3	2	4
IMM 100	Refrigeration Fundamentals	3	2	4
XXX ###	Elective	-	-	3
		12	11	20
FOURTH QUARTER*				
WLD 133	Metal Welding and Cutting Techniques	2	3	3
IMM 109	Lathe Operations I	4	6	7
IMM 133	Industrial Maintenance-Mechanical Review	1	4	3
XXX ###	Elective	-	-	3
		7	13	16

First Quarter

***Each quarter is 10 weeks in length.**

MATH 103

MASTER PROGRAM

Algebraic Concepts

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces concepts and operations which can be applied to the study of algebra. Topics include: use of variables, manipulation of algebraic expressions, solution of linear and quadratic equations, evaluation and graphing of linear and quadratic functions, and solution of systems of linear equations. Class includes lecture, applications, and homework to reinforce learning.

PREREQUISITE: **Pre-Algebra, or entrance math scores in accordance with approved DTAE admission score levels**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Basic mathematical concepts;
2. Basic algebraic concepts; and,
3. Intermediate algebraic concepts.

REQUIRED COURSE MATERIALS:

Textbook: *Introduction to Technical Mathematics*, Washington, A. J., & Triola, M. F., Menlo Park, CA: Benjamin Cummings, Latest Edition

Materials:
Scientific calculator
Graph paper
Pencils
Straight edge

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Arithmetic Operations and Order of Operations	
Units of Measurement and Approximate Numbers	
Signed numbers	
TEST 1	
Exponents, Roots, and Radicals	
Introduction to Algebra, Simple Equations and Inequalities	
Basic Algebraic Operations	
TEST 2	
Factoring	
Algebraic Operations	
Quadratic Equations	
TEST 3	
Graphs	
Simultaneous Linear Equations	
TEST 5	
FINAL EXAM - Cumulative	
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect

a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual

imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
   1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
      a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
      b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
      c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*

a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-B1 through IMM-B2; and,
   IMM-B4.

ELC 106

MASTER PROGRAM

Direct Current Circuits I

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 20** **Credit hours: 4**

COURSE DESCRIPTION:

Introduces direct current (DC) concepts and applications. Topics include: fundamental electrical principles and laws; direct current test equipment; series, parallel, and combination circuits; and basic laboratory and safety practices.

PREREQUISITE: **Algebraic Concepts**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Electrical principles and laws;
2. DC test equipment;
3. Series, parallel, and combination circuits; and,
4. Laboratory procedures and safety practices.

REQUIRED COURSE MATERIALS:

Textbook: *Electricity 1,* Kubala, Delmar Publishing Co., Latest Edition

Hand Tools/Quantity Required:

Calculator
Tool box
Volt-Ohm meter
Safety shoes
Classroom supplies
Safety glasses

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Review Basic Math	3
Electron Theory and Ohm's Law	
Test 1	
Energy and Power	3
Circuits, Symbols and Diagrams	
Test 2	
Measuring Electricity	3
Series Circuits	
Test 3	
Parallel Circuits	3
Test 4	
Series-Parallel Circuits	3
Unit 10 Review	
Test 5	
Conductors and Wire Sizes	3
Voltage Drop	
Test 6	
Batteries; Magnetics	3
Unit 15 Review	
Test 7	
DC Motors - Shunt, Series	3
Test 8	
DC Motors - Compound	3
Test 9	
Unit 20	
Final Review; Final Exam	3
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Ohm's Law Problems	2
Circuit with Source and Load	2
Series Circuits-Build and Measure Voltages and Circuits	2
Parallel Circuits-Build and Measure, Voltages and Currents	2
Series-Parallel Circuit-Build and Measure, Voltages and Currents	2
Voltage Drop Circuit	2
Charge and Test Battery	2
Wire and Run Shunt and Series Motor	2
Wire and Run Compound Motor	2
Complete all Labs	2
Total Lab Hours	**20**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested

3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-E1 through IMM-E2;
   IMM-P1; and
   IMM-Q1 through IMM-Q5.

IMM 101

MASTER PROGRAM

Industrial Maintenance Safety Procedures

COURSE SYLLABUS

Total lecture hours: 20 **Total lab hours: 10** **Credit hours: 2**

COURSE DESCRIPTION:

Provides an in-depth study of the health and safety practices required for maintaining industrial production equipment. Topics include: traffic safety, ladder safety, fire safety, safe work in confined spaces, electrical safety, emergency procedures, an introduction to OSHA regulations, MSDS Right-To-Know Law, hazardous materials safety, and safety equipment.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Traffic safety;
2. Ladder safety;
3. Fire safety;
4. Safe work in confined spaces;
5. Electrical safety;
6. Emergency procedures
7. Introduction to OSHA regulations;
8. MSDS Right-to-Know Law and hazardous materials safety; and,
9. Safety equipment.

REQUIRED COURSE MATERIALS:

Textbook: *Safety & Health,* School Craft Publishing, Latest Edition

Hand Tools/Quantity Required:

Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Information Sheet 100-1 Safety First	
Introduction to Safety	2
Video 101-1 - "Introduction to Safety"	
Lab 1	
TEST ONE	
Safety Laws	2
Video 101-3 - "Government Safety Regulations"	
Video 101-4 - "OSHA Permit-Required Confined Spaces"	
Lab 2	
TEST TWO	
Personal Protective Equipment	2
Video 101-5 - "Personal Protective Equipment"	
Video 101-6 - "Selection and Use of Personal Protective Equipment"	
Video 101-7 - "Eye Care and Safety"	
Lab 3	
TEST THREE	

Chemical Safety	2
Tool Safety	
Video 101-8 - "Hand & Power Tool Safety"	
Safe Material Handling	
TEST FOUR, FIVE, SIX	
Review all lesson material	2
MIDTERM EXAM	
Machine Safety	
Video 101-19 - "Lock-Out and Tag-Out"	
Lab 4	
TEST SEVEN	
Electrical Safety	2
Video 101-17 - "Our Invisible Friend - Electricity"	
Video 101-18 - "Electricity Safety"	
Electrical Protection	
Lab 5	
TESTS EIGHT AND NINE	
Fire Protection	2
Video 101-20 - "Fire Protection"	
Handout 101-2 - Types of Fire Extinguishers	
Lab 6	
TEST TEN	
Health Protection	2
Video 101-9 - "Hand, Wrist and Finger Safety"	
Video 101-13 - "Back Care and Safety"	
Lab 7	
TEST ELEVEN	
Safe Work Practices	2
Video 101-10 - "Working Safely"	
Video 101-2 - "Safety Attitudes and Practices"	
Lab 8	
TEST TWELVE	
Complete all assignments	2
Review all lessons	
FINAL EXAM	
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Lab 1	
Lab 2	
Lab 3	
Lab 4	
Lab 5	
Lab 6	
Lab 7	
Lab 8	
Total Lab Hours	**10**

COURSE OBJECTIVES: SCANS COMPETENCIES

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The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   *1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   *2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted

grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner

c. Demonstrates ability to formulate and follow personal schedules

d. Demonstrates ability to wisely use classroom time

e. Demonstrates use of good study habits and skills

f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*

a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6.

IMM 108

MASTER PROGRAM

Industrial Mechanics I

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 50** **Credit hours: 7**

COURSE DESCRIPTION:

Provides instruction in those basic physics concepts which are applicable to mechanics of industrial production equipment; teaches basic industrial application of mechanical principles with emphasis on power transmission and specific mechanical components. Topics include: mechanical tools, fasteners, basic mechanics, lubrication, bearings, and packings and seals.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Mechanical tools;
2. Fasteners;
3. Basic mechanics;
4. Lubrication;
5. Bearings; and,
6. Packings and seals.

REQUIRED COURSE MATERIALS:

Textbook: *Millwrights & Mechanics Guide,* Latest Edition

Lab Manual: *Millwrights & Mechanics Guide,* Latest Edition

Hand Tools/Quantity Required:

Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Drawings, Sketching, Machinery Instructions, Power Transmission	5
V-Belt Drives, Flat Belts	5
Chains, Couplings, Bearings	5
Packing and Seals	5
Mechanical Fasteners	5
Wood Fasteners	5
Gears	5
Screw Threads	5
Lubrication	5
Total Lecture Hours	**50**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Sketch Pillow Block, Label Drawing	5
Connect V-Belt Drive, Connect Flat Belt Drive	5
Demonstrate Chain Replacement	5
Demonstrate Removal and Installation of Mechanical Seals	5
Demonstrate Tightening Threaded Fasteners	5
Demonstrate Proper Installation of Nails, Wood Screws and Lag Screws	5
Demonstrate Installation of Spur, Helical	

and Worm Gears		5
Demonstrate Thread Tapping (English and Metric)		5
Demonstrate Lubrication Using Grease and Oil		5
Complete all Labs, Review		5
	Total Lab Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2;
   IMM-I1 through IMM-I4
   IMM-K1 through IMM-K7;
   IMM-L1 through IMM-L2;
   IMM-M1 through IMM-M2;
   IMM-O1 through IMM-O2;
   IMM-P2;

IMM-P4; and
IMM-R1 through IMM-R5.

CMP 101

MASTER PROGRAM

Introduction to Microcomputers

COURSE SYLLABUS

Total lecture hours: 10 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

Introduces fundamental concepts and operations necessary to utilize microcomputers. Emphasis is placed on basic functions and familiarity with computer use. Topics include: computer terminology; computer operating systems; data storage; file management; equipment care and operation; and an introduction to word processing, database, and spreadsheet applications.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Computer terminology;
2. Disk operating systems;
3. Data storage;
4. File management;
5. Hardware and software care and operation; and,
6. Introductory word processing, database, and spreadsheet applications.

REQUIRED COURSE MATERIALS:

Textbook: *Learning to Use Microcomputer Applications,* Shelly, Cashman, Markowicz, Latest Edition

Lab Manual: *Learning to Use Microcomputer Applications,* Shelly, Cashman, Markowicz, Latest Edition

Materials/Quantity Required:

Classroom Supplies	1
Computer	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Computers	1
TEST 1	
Working With Files on a Disk	1
Managing and Organizing Files on Disks	1
TEST 2	
Word Processing Using WordPerfect	1
The Keyboard	
TEST 3	
Formatting Text	1
TEST 4	
Review	
Intro to Internet	1
Moving, Searching and Replacing Text	1
TEST 5	
Formatting a Document	1
TEST 6	
Merging Documents	1
TEST 7	
Review; FINAL EXAM	1
Total Lecture Hours	**10**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Hardware and Software	4
Format, Directory, and Rename Commands	4
Root Directory, MD and CD Commands	4
Creating and Editing a Document	4
Deleting and Blocking Text	4
Printing Multiple Pages and Spell Check	4
Identify, Text, Save a Document	4
Page Format Menu, Line Format Menu	4
Merging, Creating a Primary File, Creating a Secondary File	4
Complete All Labs	4
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations

4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

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e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
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   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
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   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking****: Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-N1 through IMM-N2.

MASTER Curriculum
INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 103	Algebraic Concepts	5	0	5
ELC 106	Direct Current Circuits I	3	2	4
IMM 101	Industrial Maintenance Safety Procedures	2	1	2
IMM 108	Industrial Mechanics I	5	5	7
CMP 101	Introduction to Microcomputers	1	4	3
		16	12	21
SECOND QUARTER*				
ENGL 101	English	5	0	5
ELC 109	Alternating Current I	3	2	4
ELC 110	Alternating Current II	3	2	4
IMM 128	Pumps & Piping Systems	1	4	2
IMM 113	Industrial Hydraulics	6	4	8
		18	12	23
THIRD QUARTER*				
PSY 100	Interpersonal Relations and Professional Development	3	0	3
IMM 110	Industrial Mechanics II	3	7	6
IMM 115	Industrial Pneumatics	3	2	4
IMM 100	Refrigeration Fundamentals	3	2	4
XXX ###	Elective	-	-	3
		12	11	20
FOURTH QUARTER*				
WLD 133	Metal Welding and Cutting Techniques	2	3	3
IMM 109	Lathe Operations I	4	6	7
IMM 133	Industrial Maintenance-Mechanical Review	1	4	3
XXX ###	Elective	-	-	3
		7	13	16

Second Quarter

***Each quarter is 10 weeks in length.**

ENGL 101

MASTER PROGRAM

English

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the development and improvement of written and oral communication abilities. Topics include: analysis of writing techniques used in selected readings, writing practice, editing and proofreading, research skills, and oral presentation skills. Homework assignments reinforce classroom learning.

PREREQUISITE/COREQUISITE: **English III and Reading III, or the equivalent.**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Analysis of writing techniques used in selected readings;
2. Writing practice;
3. Editing and proofreading;
4. Research skills; and,
5. Oral presentation skills.

REQUIRED COURSE MATERIALS:

Textbook: *English Skills*, Langan, J., New York: McGraw-Hill, Latest Edition

Materials:
Loose leaf paper
Loose leaf binder
Blue or black pen
Pencil
Highlighter

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Grammar Pretest and Paragraph	5
Introduction to the Course	
The Computer Grammar Project	
One-minute Introductory Speech: "Who Am I?"	
Introduction to the Paragraph	5
The Evaluation of a Paragraph	
"The Paper Format"	
Introduction to the Portfolio or Journal Notebook (Entries will be evaluated throughout the quarter at the instructor's discretion)	
Example Paragraph	
Spelling Test #1 (Words 1-50)	
"Important Factors in Writing"	5
Narrative Paragraph	
Grammar and Mechanics Skills as Needed	
Spelling Test #2 (Words 50-100)	
Library Orientation and Library Project	5
The Abstract	
Grammar and Mechanics Skills as Needed	
Spelling Test #3 (Words 100-150)	
"Speaking One to One Thousand"	5
Listening Skills	
Oral Presentation #2	
Grammar and Mechanics Skills as Needed	
Spelling Test #4 (Words 150-200)	
"The First and Second Steps in Writing"	5
"The Third and Fourth Steps in Writing"	
Description Paragraph	
Dividing and Classifying Paragraph OR	

Comparing and Contrasting Paragraph	
Turn in Portfolio or Journal Notebook for final evaluation	
Spelling Test #5 (Words 200-250)	
Oral Presentation #3: The Process Speech (with the help of a visual aid)	**5**
Grammar and Mechanics Skills as Needed	
Spelling Test #6 (Words 250-300)	
Business Items: The Resume, Cover Letter, and Memo	**5**
Cause and Effect Paragraph	
Grammar and Mechanics Skills as Needed	
Spelling Test #7 (Words 300-350)	
"Four Bases for Evaluating Writing"	**5**
Computer Grammar project due	
Grammar Post-Test	
Spelling Test #8 (Words 350-400)	
Review Week	**5**
Spelling Test #9 (Words 400-450)	
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides

feedback

B. ***Interpersonal:*** *Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

      d. Demonstrates ability to read, interpret, and follow

schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into

practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process

d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. Demonstrates use of simple logic

b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships

d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks

b. Demonstrates ability to separate work and personal behaviors

c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors

d. Demonstrates ability to accept personal strengths and

weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism

f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions

b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner

c. Demonstrates ability to formulate and follow personal schedules

d. Demonstrates ability to wisely use classroom time

e. Demonstrates use of good study habits and skills

f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*

a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings

ELC 109

MASTER PROGRAM

Alternating Current I

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 20** **Credit hours: 4**

COURSE DESCRIPTION:

Introduces the theory and application of varying sine wave voltages and current. Topics include: AC wave generation, oscilloscope operation, inductance, and capacitance.

PREREQUISITE: **Direct Current Circuits I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. AC wave generation;
2. Oscilloscope operation;
3. Inductance; and,
4. Capacitance.

REQUIRED COURSE MATERIALS:

Textbook: *Electricity 2,* Kubala, Delmar Publishing, Latest Edition

Lab Manual: Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Safety Glasses
Classroom Supplies
Calculator
Volt-Ohm Meter w/Test Leads

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Alternating Current	3
Wheatstone Bridge	3
Electronic Charges	3
Filmstrip 802-6, "Magnetism and Electro-Magnetism", Bergwall	
Capacitors	3
Inductors	3
Oscilloscope	3
Inductive Circuits	3
Capacitive Circuits	3
Reactive Circuits	3
Filmstrip 802-7, "Inductors and Inductive Reactance", Bergwall	
Filmstrip #802-9, "Capacitors and Capacitive Reactive", Bergwall	
Final Exam	3
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topic	Contact Hrs.
Alternating Current	2
Construct Wheatstone Bridge	2
Electrostatic Charges	2
Build Capacitor Circuit	2
Build Inductor Circuit	2
Oscilloscope to Measure Voltage,	

Frequency	2
Inductive Circuits - Measure Voltage	2
Capacitive Circuits - Measure Voltage	2
Reactive Circuits - Measure Current	2
Complete all Labs	2
Total Lab Hours	**20**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-C1 through IMM-C3;
   IMM-E1 through IMM-E2;
   IMM-P1; and,
   IMM-Q1 through IMM-Q5.

ELC 110

MASTER PROGRAM

Alternating Current II

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 20** **Credit hours: 4**

COURSE DESCRIPTION:

Continues development of AC concepts with emphasis on constructing, verifying, and troubleshooting reactive circuits using RLC theory and oscilloscopes. Topics include: simple RLC circuits, AC circuit resonance, passive filters, transformer theory, and applications, and non-sinusoidal wave forms.

PREREQUISITE: **Alternating Current I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Simple RLC circuits;
2. AC circuit resonance;
3. Passive filters;
4. Transformer theory and applications; and,
5. Non-sinusoidal wave form.

REQUIRED COURSE MATERIALS:

Textbook: *Electricity 2,* Kubala, Delmar Publishing, Latest Edition

Lab Manual: Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Tools
Safety Glasses
Classroom Supplies
Calculator
Volt-Ohm Meter w/test leads

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
AC Power—Single Phase	3
Resonance—Series and Parallel	3
AC Power—Three Phase	3
Impedance Matching	3
Transformer—Single Phase	3
Filmstrip #802d-8, "Transformer", Bergwall	
Transformer—Three Phase	3
Motors—Single Phase	3
Motors—Three Phase	3
Generators—Three Phase	3
Final Exam	3
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Connect Single Phase Power Circuit and Measure Power	2
Connect Series and Parallel Resonance Circuits and Measure Impedance	2
Connect Three Phase Circuits; Measure	

Voltages	2
Connect Impedance Matching Circuit and Measure Impedance	2
Connect Transformer; Measure Voltage	2
Connect Delta and Wye Three Phase Transformers	2
Wire Single Phase Motors, Start and Run, Measure Torque	2
Wire Three Phase Motors, Start and Run	2
Wire Three Phase Generator to Supply Three Phase Load	2
Complete All Labs	2
Total Lab Hours	**20**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.

5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-C1 through IMM-C3;
   IMM-E1 through IMM-E2
   IMM-H7;

IMM-P1; and
IMM-Q1 through IMM-Q5.

IMM 128

MASTER PROGRAM

Pumps and Piping Systems

COURSE SYLLABUS

Total lecture hours: 10 **Total lab hours: 40** **Credit hours: 2**

COURSE DESCRIPTION:

Provides instruction in the operation of industrial pumps, valves, and piping/delivery systems with emphasis on installation procedures, maintenance and repair. Topics include: pump identification, pump operations, pump installation, maintenance, troubleshooting, piping systems, and installation and repair of piping systems.

PREREQUISITES: **Industrial Mechanics I; Industrial Pneumatics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Pump identification;
2. Pump operation;
3. Pump installation, maintenance, and troubleshooting;
4. Piping systems; and,
5. Installation of piping systems.

REQUIRED COURSE MATERIALS:

Textbook 1: *Pumps*, Schoolcraft Publishing, Latest Edition

Textbook 2: *Piping Systems*, Schoolcraft Publishing, Latest Edition

Lab Manual: *Fluid Power*, Parker, Latest Edition

Lab manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Gear Pumps	1
Vane Pumps	1
Rotary Piston Pumps	1
Reciprocating Piston Pumps	1
Bent Axis Piston Pump	1
Axial Piston Pump	1
Filters - Intake and Sump	1
Rigid Pipe	1
Flexible Piping	1
Plan Piping Installation	1
Total Lecture Hours	**10**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Rebuild Gear Pump	4
Rebuild Vane Pump	4
Rebuild Rotary Piston Pump	4
Rebuild Reciprocating Piston Pump	4
Rebuild Bent Axis Piston Pump	4
Rebuild Axial Piston Pump	4
Remove and Install Filters	4

Install Rigid Piping System		4
Install Flexible Piping System		4
Plan Piping Installation		4
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- D. *Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems

2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. Self-Esteem: Believes in own self-worth and maintains a positive view of self

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
   IMM-E1 through IMM-E2;
   IMM-H2 through IMM-H6;
   IMM-H8 through IMM-H9
   IMM-K1 through IMM-K7;
   IMM-M1 through IMM-M2; and,
   IMM-P3 through IMM-P4.

IMM 113

MASTER PROGRAM

Industrial Hydraulics

COURSE SYLLABUS

Total lecture hours: 60 **Total lab hours: 40** **Credit hours: 8**

COURSE DESCRIPTION:

Provides instruction in fundamental concepts and theories for the safe operation of hydraulic components and systems. Topics include: hydraulic theory, suction side of pumps, actuators, valves, pumps/motors, accumulators, symbols and circuitry, types of fluids, filters, servicing safety, preventative maintenance, and troubleshooting.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Hydraulic theory;
2. Suction side of pumps;
3. Actuators;
4. Valves;
5. Pumps/motors;
6. Accumulators;
7. Symbols and circuitry;
8. Types of fluids;
9. Filters;
10. Servicing safety;
11. Preventive maintenance; and,
12. Troubleshooting.

REQUIRED COURSE MATERIALS:

Textbook: *Industrial Hydraulics Manual,* Latest Edition

Lab Manual: *Fluid Power,* Parker, Latest Edition

Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Tools	
Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Hydraulic Theory	**5**
Definition of Terms	
Principles	
Operational Conditions	
Computing Units of Measure	
Power Transmission	
Suction Side of Pumps	**7**
Cavitation	
Atmospheric Pressure	
Actuators	**6**
Inspection	
Alignment	
Valves	**16**
Inspection	

Pressure		
Flow Rate		
Null Procedure		
Replacement and Adjustment		
Pumps/Motors		6
Inspection Accumulators		2
Testing		
Replacement		
Symbols and Circuitry		5
Component Identification		
Types of Fluids		5
Composition of Fluids		
Types		
Selection of Oil		
Filters		2
Verification		
Cleaning and Replacement		
Servicing Safety		2
Protective Clothing		
Repair and Replacement		
Preventive Maintenance		2
Program Elements		
Program Selection		
Fluid Checks		
Replacement		
Alignment		
Lines		
Troubleshooting		2
Application		
	Total Lecture Hours	**60**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Suction Side of Pumps	2
Actuators	6
Valves	8
Pumps/Motors	5
Inspection Accumulators	4
Filters	5
Preventive Maintenance	5
Troubleshooting	5
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
IMM-A1 through IMM-A6;
IMM-B1 through IMM-B4
IMM-C1 through IMM-C3;
IMM-D1;
IMM-E1 through IMM-E2;
IMM-H3 through IMM-H8;
IMM-M1 through IMM-M2;
IMM-O1 through IMM-O2; and,
IMM-P4.

MASTER Curriculum
INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 103	Algebraic Concepts	5	0	5
ELC 106	Direct Current Circuits I	3	2	4
IMM 101	Industrial Maintenance Safety Procedures	2	1	2
IMM 108	Industrial Mechanics I	5	5	7
CMP 101	Introduction to Microcomputers	1	4	3
		16	12	21
SECOND QUARTER*				
ENGL 101	English	5	0	5
ELC 109	Alternating Current I	3	2	4
ELC 110	Alternating Current II	3	2	4
IMM 128	Pumps & Piping Systems	1	4	2
IMM 113	Industrial Hydraulics	6	4	8
		18	12	23
THIRD QUARTER*				
PSY 100	Interpersonal Relations and Professional Development	3	0	3
IMM 110	Industrial Mechanics II	3	7	6
IMM 115	Industrial Pneumatics	3	2	4
IMM 100	Refrigeration Fundamentals	3	2	4
XXX ###	Elective	-	-	3
		12	11	20
FOURTH QUARTER*				
WLD 133	Metal Welding and Cutting Techniques	2	3	3
IMM 109	Lathe Operations I	4	6	7
IMM 133	Industrial Maintenance-Mechanical Review	1	4	3
XXX ###	Elective	-	-	3
		7	13	16

Third Quarter

***Each quarter is 10 weeks in length.**

1. Satisfactory perform on written, oral examinations;
2. Satisfactory perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Human Relations Skills	**6**
Goal Setting	
Stress Management	
Behavior Problems	
Personal Instructions	
Problem Solving/Decision Making	
Job Acquisition	**15**
Job Search	
Career Goals	
Employment Documents	
Interviewing	
Job Retention Skills	**3**
Office Relationship	
Time Management	
Job Advancement Skills	**3**
Performance Appraisal	
Supervisory Chain	
Professional Image Skills	**3**
Image	
Attitude	
Total Lecture Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
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3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

IMM 110

MASTER PROGRAM

Industrial Mechanics II

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 70** **Credit hours: 6**

COURSE DESCRIPTION:

Continues the application of mechanical principles to industrial production equipment with emphasis on power transmission and mechanical components. Emphasis is placed on alignment and tension. Topics include: mechanical drive systems, couplings and alignment, clutches and brakes, linkage and levers, mechanical troubleshooting, and preventative maintenance.

PREREQUISITE: **Industrial Mechanics I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Mechanical drive systems;
2. Couplings and alignment;
3. Clutches and brakes;
4. Linkage and levers;
5. Mechanical troubleshooting; and,
6. Preventive maintenance.

REQUIRED COURSE MATERIALS:

Textbook 1: *Pumps*, Schoolcraft Publishing, Latest Edition

Textbook 2: *Fluid Power*, Parker, Latest Edition

Lab Manual: Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Tools	
Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Power Transmission	3
Mechanical Drive Systems—Belts	3
Test 1	
Mechanical Drive Systems—Chains	3
Couplings-Alignment	3
Test 2	
Portable Power Tools	3
Clutches and Brakes	3
Test 3	
Linkage and Levers	3
Preventive Maintenance	3
Test 4	
Rigging	3
Mechanical Troubleshooting	3
Final Exam	—
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Power Transmission Lab	7
Belt Drive System Lab	7

Chain Drive System Lab		7
Alignment Lab - Shaft		7
Portable Power Tool Lab		7
Clutch and Brake Lab		7
Lever and Linkage Lab		7
Additional Alignment - Coupling		7
Rigging Lab; Rope; Chain		7
Complete All Labs		7
	Total Lab Hours	**70**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information

2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

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e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
   IMM-C1 through IMM-C3;
   IMM-D1 through IMM-D2;
   IMM-E1 through IMM-E2;
   IMM-H7;
   IMM-I1 through IMM-I4;
   IMM-K1 through IMM-K7;
   IMM-L1 through IMM-L2;
   IMM-M1 through IMM-M2;
   IMM-O1 through IMM-O2;

IMM-P2;
IMM-P4;
IMM-R1 through IMM-R5; and,
IMM-S1 through IMM-S7.

IMM 115

MASTER PROGRAM

Industrial Pneumatics

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 20** **Credit hours: 4**

COURSE DESCRIPTION:

Provides instruction in fundamental concepts and theories for the safe operation of pneumatic components and systems. Topics include: pneumatic theory, preventative maintenance, compressors, regulators, pneumatic valves, actuators, servicing safety, and troubleshooting.

PREREQUISITE: **Industrial Hydraulics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Pneumatic theory;
2. Preventive maintenance;
3. Compressors;
4. Regulators;
5. Pneumatic valves;
6. Actuators;
7. Servicing safety; and,
8. Troubleshooting.

REQUIRED COURSE MATERIALS:

Textbook: *Industrial Pneumatic Technology,* Parker Fluid Power, Latest Edition

Lab Manual: *Industrial Pneumatic Technology,* Parker Fluid Power, Latest Edition

Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

Tool Box	1
Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Evolution of Compressed Air Force Transmission	3
Energy Transmission Using a Pneumatic System	3
Control of Pneumatic Energy	
Test 1	
Compressors	3
Test 2	
Aftercoolers, Dryers, Receives-Air Distribution System	3
Check Valves, Cylinders, Motors	3
Directional Control Valves	3
Test 3	
Flow Control Valves, Silencers, Quick Exhaust	3

Test 4		
Regulators, Boosters and Sequence Valves		3
Air Preparation		3
Final Exam		3
	Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Force Transmission	2
Control of Pneumatic Energy	2
Compressors	2
Air Distribution System	2
Cylinders	2
Directional Control Valves	2
Sequence Valves	2
Air Preparation	2
Total Lab Hours	**20**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;

IMM-C1 through IMM-C3;
IMM-D1;
IMM-E1 through IMM-E2;
IMM-H2;
IMM-H5 through IMM-H6; and,
IMM-H9.

IMM 100

MASTER PROGRAM

Refrigeration Fundamentals

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 20** **Credit hours: 4**

COURSE DESCRIPTION:

Introduces basic concepts and theories of refrigeration. Topics include: the laws of thermodynamics, pressure and temperature relationships, heat transfer, the refrigeration cycle and safety.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Laws of thermodynamics;
2. Pressure and temperature relationships;
3. Heat transfer;
4. Refrigeration cycle; and,
5. Safety.

REQUIRED COURSE MATERIALS:

Textbook 1 *Modern Refrigeration and Air Conditioning,* Althouse et al., Latest Edition

Textbook 2 *Study Guide for Modern Refrigeration and Air Conditioning,* Althouse et al., Latest Edition

Hand Tools/Quantity Required:

3 ring notebook
#2 pencil
Goggles–flexible fitting
Hooded ventilation
Pocket thermometer—40 to 60 degrees Fahrenheit

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Laws of Thermodynamics	7
First law of thermodynamics	
Second law of thermodynamics	
Definition of refrigeration terms and purposes	
Pressure and Temperature Relationships	6
Definition of pressure	
Relationship of pressure and temperature - P.T. chart	
Pressure - Atmospheric, gauge and absolute	
Gas laws	
Heat and Heat Transfer	6
Definitions of heat and temperature	
Temperatures - Fahrenheit, Celsius, and absolute	
Heat - Specific, sensible and latent	
Refrigeration Cycle	8
Condensation	
Evaporation	
System Components	
Basic refrigeration cycle	
Safety	3
General shop safety	
Emergency procedures	—

Total Lecture Hours 30

LAB OUTLINE:

Lab Topics	Contact Hrs.
Laws of Thermodynamics	5
Pressure and Temperature Relationships	5
Heat and Heat Transfer	5
Refrigeration Cycle	5
Total Lab Hours	20

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information

2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2;
   IMM-H1;
   IMM-H3 through IMM-H8;
   IMM-J1 through IMM-J3;
   IMM-P1; and,
   IMM-Q1 through IMM-Q5.

MASTER Curriculum
INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 103	Algebraic Concepts	5	0	5
ELC 106	Direct Current Circuits I	3	2	4
IMM 101	Industrial Maintenance Safety Procedures	2	1	2
IMM 108	Industrial Mechanics I	5	5	7
CMP 101	Introduction to Microcomputers	1	4	3
		16	12	21
SECOND QUARTER*				
ENGL 101	English	5	0	5
ELC 109	Alternating Current I	3	2	4
ELC 110	Alternating Current II	3	2	4
IMM 128	Pumps & Piping Systems	1	4	2
IMM 113	Industrial Hydraulics	6	4	8
		18	12	23
THIRD QUARTER*				
PSY 100	Interpersonal Relations and Professional Development	3	0	3
IMM 110	Industrial Mechanics II	3	7	6
IMM 115	Industrial Pneumatics	3	2	4
IMM 100	Refrigeration Fundamentals	3	2	4
XXX ###	Elective	-	-	3
		12	11	20
FOURTH QUARTER*				
WLD 133	Metal Welding and Cutting Techniques	2	3	3
IMM 109	Lathe Operations I	4	6	7
IMM 133	Industrial Maintenance-Mechanical Review	1	4	3
XXX ###	Elective	-	-	3
		7	13	16

Fourth Quarter

***Each quarter is 10 weeks in length.**

WLD 133

MASTER PROGRAM

Metal Welding and Cutting Techniques

COURSE SYLLABUS

Total lecture hours: 20 **Total lab hours: 30** **Credit hours: 3**

COURSE DESCRIPTION:

Provides instruction in the fundamental use of the electric arc welder and the oxyacetylene cutting outfit. Emphasis is placed on safe setup and use of equipment. Topics include: safety practices, arc welding equipment and setup, oxyfuel welding, flame cutting equipment and setup, and welding and cutting procedures.

PREREQUISITE: **Provisional Admission**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Arc welding;
2. Flame cutting;
3. Safety practices;
4. Oxyfuel welding; and,
5. Brazing.

REQUIRED COURSE MATERIALS:

Textbook: *Welding Principles & Applications,* Latest Edition

Lab Manual: *Welding Principles & Applications,* Latest Edition

Hand Tools/Quantity Required:

Welding Hood
Safety Gloves for Welding
Safety Vest for Welding

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Arc Welding	4
Principles and Terminology	
Applications	
Safe Operating Procedures	
Metal Joints and Preparation	
Arc Weld	
Flame Cutting	5
Principles and Terminology	
Applications	
Safe Operating Procedures	
Work Preparation	
Flame Cutting	
Safety Practices	6
General	
Arc Welding Applications	
First Aid	
Oxyfuel Welding	3
Principles and Terminology	
Applications	
Safe Operating Procedures	
Metal Joints and Preparation	
Oxyfuel Weld	
Brazing	2
Principles and Terminology	
Applications	
Safe Operating Procedures	
Metal Joints and Preparation	
Braze Metal	
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Arc Welding	**8**
Flame Cutting	**7**
Safety Practices	**1**
Oxyfuel Welding	**7**
Brazing	**7**
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information

2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B2;
   IMM-B4 through IMM-B6;
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2; and,
   IMM-G1 through IMM-G3.

IMM 109

MASTER PROGRAM

Lathe Operations I

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 60** **Credit hours: 7**

COURSE DESCRIPTION:

Provides opportunities for students to develop skill in the use of bench grinders and lathes. Topics include: lathes, bench grinders, bench grinder operations, lathe calculations, lathe setup, and lathe operations.

PREREQUISITE: **Provisional Admission**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Lathes;
2. Bench grinders;
3. Bench grinder operations;
4. Lathe calculations;
5. Lathe setup; and,
6. Lathe operations.

REQUIRED COURSE MATERIALS:

Textbook: *Technology of Machine Tools,* Latest Edition

Lab Manual: *Technology of Machine Tools,* Latest Edition

Hand Tools/Quantity Required:
Hand Tools
Calculator

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Lathes	10
Lathe Parts	
Lathe Controls	
Lathe Lubrication System	
Lathe Maintenance	
Blueprint Reading	
Bench Grinders	3
Wheel Selection	
Bench Grinder Operations	2
Sharpening	
Grinding	
Lathe Calculations	10
Speeds and Feeds	
Tooling Requirements	
Other Calculations (Tapers, Threads, Drilling)	
Lathe Setup	10
Setup	
Lathe Operations	5
Operations	
Total Lecture Hours	40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Lathes	3
Bench Grinders	2
Bench Grinder Operations	5
Lathe Calculations	5

Lathe Setup		**15**
Lathe Operations		**10**
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- D. *Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation

3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

a. Accepts personal strengths and weaknesses and uses the same for positive advancement
b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
IMM-A1 through IMM-A6;
IMM-B1 through IMM-B6;
IMM-C1 through IMM-C3;
IMM-D1 through IMM-D2;
IMM-E1 through IMM-E2; and,
IMM-F1 through IMM-F6.

IMM 133

MASTER PROGRAM

Industrial Maintenance–Mechanical Review

COURSE SYLLABUS

Total lecture hours: 10 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

Summarizes and integrates all previous CMP, ELC, and IMM courses designed to assist Industrial Maintenance Technology students in assembly, troubleshooting, and repair of multi–system machinery and devices. Topics include: electrical, mechanical, and fluidic interfacing in complex and industrial equipment.

PREREQUISITE/COREQUISITE: All Program Courses

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Math;
2. Alternating current;
3. Direct current;
4. AC/DC motors;
5. Refrigeration;
6. Pumps and piping systems;
7. Industrial hydraulics;
8. Industrial pneumatics;
9. Lathe operations;
10. Industrial mechanics;
11. Welding; and,
12. Safety.

REQUIRED COURSE MATERIALS:

Textbook : All previous books

Lab Manual: All previous books

Hand Tools/Quantity Required:

Tools	1 set
Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Diagnostic Test, Safety, AC and DC Circuits	1
Math, Motor Controls	1
Pneumatics, Pumps and Piping Systems	1
Test 1	
Rebuild Air Compressor (Project 1)	1
Rebuild Air Compressor (Project 1) (continued)	1
Test 2	
Complete All Assignments and Project 1	1
Mechanics	1
Hydraulics	1
Test 3	
Lathe Operations, Welding	1

Refrigeration		1
Complete All Assignments		
Final Exam		—
	Total Lecture Hours	**10**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Rebuild Air Compressor	12
Rebuild Pump	12
Troubleshoot Motor Control	8
Troubleshoot Lathe	4
Troubleshoot Refrigeration System	4
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations

4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B6
   IMM-C1 through IMM-C3
   IMM-D1 through IMM-D2
   IMM-E1 through IMM-E2;

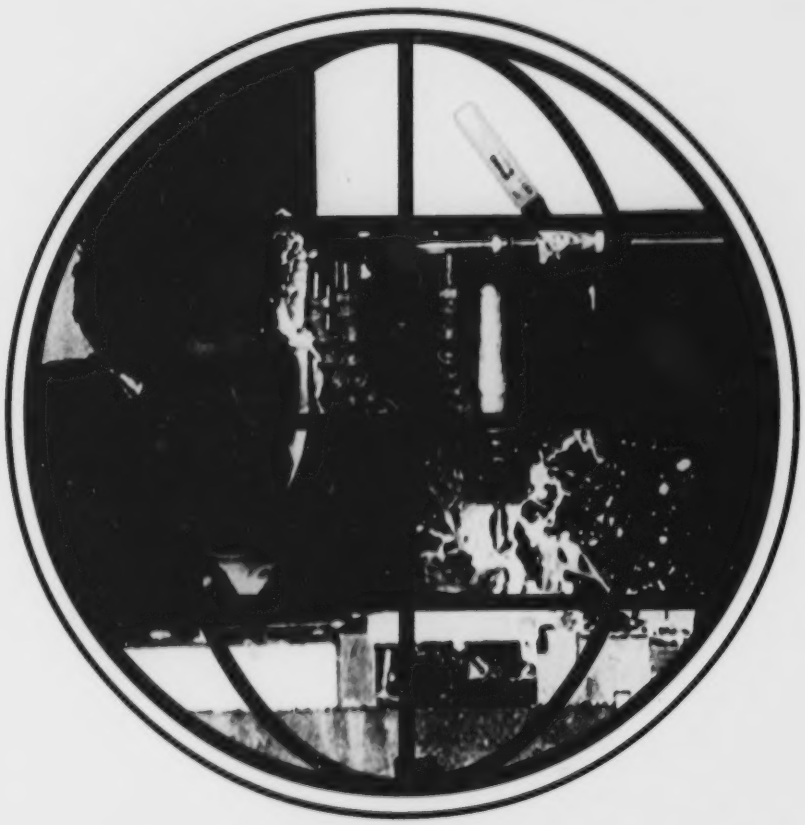
IMM-F1 through IMM-F6;
IMM-G1 through IMM-G3;
IMM-H1 through IMM-H9;
IMM-I1 through IMM-I4;
IMM-J1 through IMM-J3;
IMM-K1 through IMM-K7;
IMM-L1 through IMM-L2;
IMM-M1 through IMM-M2;
IMM-N1 through IMM-N2;
IMM-O1 through IMM-O2;
IMM-P1 through IMM-P4;
IMM-Q1 through IMM-Q5;
IMM-R1 through IMM-R5; and,
IMM-S1 through IMM-S7.

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY



Industrial Maintenance Series

INSTRUCTOR'S HANDBOOK

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MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Industrial Maintenance Series

INSTRUCTOR'S HANDBOOK

Supported by the National Science Foundation's Advanced Technological Education Program

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"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

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MASTER Consortia of Employers and Educators

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MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.
Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, AUGUSTA, GA
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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).**

Each Technical Training Module has been designed to be:

* Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as "competency-based training".

* Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.

* Modular in design, to allow trainers to select lessons which are applicable to their training needs.

* Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.

* Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:
  - a standardized lesson plan,
  - an assessment instrument,
  - a listing of commercially available resources (e.g. recommended textbooks, instructor guides, student manuals, and videos),
  - new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks →												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand-held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubr. coating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A1

Subject: **Industrial Maintenance** **Time: 6 Hrs.**

Duty: **Practice Safety**
Task: Use Protective Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Instructional Materials:

Overhead Projector;
Gloves
Safety Goggles
Dust Mask
Hearing Protection (ear plugs and ear muffs)
Face Shields
Handout Reading Assignments
MASTER Handout (IMM-A1-HO)
Copy of 29 CFR 1910 Regulations
MASTER Laboratory Aid (IMM-A1-LA)
MASTER Laboratory Worksheet (IMM-A1-LW)
MASTER Self-Assessment

References:

Complete Text of OSHA Guidelines - 29 CFR 1910

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, ***Standards and Recommended Practices;*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Air Purifying Respirators, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Personal Protection, - 20m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Using Respirators In Hazardous Environments, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Four Elements of Respiratory, - 11m - Video Tape, Latest Edition

Safety, Environmental Affairs Journal, - 33:08m - Video Tape - Coastal Video Communication, 3083 Brickhouse Court, Virginia Beach, VA 23452, Latest Edition

Protective Clothing, - 6:13m - Video Tape, Latest Edition

Hearing Protection Training, 1100 Series Ear Plugs, - 2m - Video Tape, Latest Edition

Lifting, Eye Protection and Hand Tool Safety, 20m - Video Tape - BBP, Latest Edition

Advanced Ind. Head Protection, - 20m - Video Tape, E.D. Bellard Co., Latest Edition

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Student Preparation:

All students must prepare themselves to enhance their attitudes toward safety. Such preparation may begin by the students asking themselves the following basic questions daily:

1. Is my hair properly stowed to prevent accidents?
2. Am I wearing any jewelry?
3. Do I have the proper shoes?
4. Do I have my eye shields (safety glasses)?
5. Is my work area free of debris and clean?
6. Does my machine have all its safeguards?
7. Is my machine working properly?
8. Do I know where the nearest fire extinguisher is?

Introduction:

Working safely should be the concern of every individual. Safety includes protecting yourself and others from injury. While others — your employer, your family, governmental agencies, and insurance companies — are concerned for your well-being, you have the final responsibility for your safety in the workplace. Being aware of your surrounding and selecting and using correct safety equipment is your responsibility.

Presentation Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations

D. Near high pressure water, air, or other medians, i.e., oil
E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
A. Generally anytime while in a construction or manufacturing environment
B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
A. Ear plugs
B. Ear muffs
C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
A. Grinding
B. Working with rough metals
C. Working with multi strand steel cables
D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
A. Plant engineering/ventilation
B. Use of respirators or bubble suits
C. Review OSHA requirements for fiber glass, asbestos and chemical protection

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Practical Application:

1. Instructor will demonstrate selection and proper use of safety equipment.
2. Students will be allowed to practice the use of safety equipment.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A2) dealing with accident prevention.

IMM-A1-HO
Use Protective Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection

and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.

Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians, i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals
   - C. Working with multi strand steel cables
   - D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   - A. Plant engineering/ventilation
   - B. Use of respirators or bubble suits
   - C. Review OSHA requirements for fiber glass, asbestos and chemical protection

IMM-A1-LA
Use Protective Equipment
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-A1-LW
Use Protective Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

Name_____ Date_____

IMM-A1
Use Protective Equipment
Self-Assessment

1. What should not be worn around rotating or other movable-parts machinery?
_____

2. Name two types of devices which provide protection to the eye.
_____
_____

3. There are three types of coverings that provide protection from objects striking the head. Name two of them.
_____
_____

4. How do you determine if a pair of glasses are safety glasses?
_____

5. Of the two types of ear protection, which generally gives the best protection?
_____

6. What type of safety devices and apparel should be worn when you use solvents to clean parts or surfaces?
_____
_____

7. List all types of hearing protection.
_____
_____
_____

8. List all types of safety glasses.
_____
_____

9. What is purpose of eyewash equipment?

_____

_____

10. What is FDA?

_____

_____

IMM-A1
Use Protective Equipment
Self-Assessment Answer Key

1. Loose clothing

2. a. Safety glasses
   b. Goggles

3. a. Hard hat
   b. Bump hat
   c. Skull hat

4. Manufacture's symbol on lens and frames

5. Ear muffs

6. Rubber or plastic covered gloves and apron plus safety glasses

7. Ear muffs, ear plugs

8. Goggles, safety glasses

9. Dilute toxic chemical in eye(s)

10. Food and drug administration

IMM-A2

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A2

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Practice Safety
Task: Accident Prevention

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employee's responsibility if a potential accident or unsafe condition exists; and,
d. Select specific tasks that have the potential to cause an injury.

Instructional Materials:

Reading Assignment
MASTER Handout (IMM-A2-HO)
Paper
Pencil
Chalkboard
Overhead Projector
MASTER Self-Assessment

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data*, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston - Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965),* Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Hazard Communication Standard - Video Tape, Latest Edition

Supervisors Development Program - 10m - Video Tape - National Safety Council, Latest Edition

Behavioral Methods for Accident Prevention - 19m - Video Tape - Behavioral Science Technology, 323 East Matillia St, Suite 215, Ojai, CA 93023, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"

Introduction:

Accident prevention is the responsibility of management and every employee. You must continually be alert for potential or actual unsafe conditions. An attitude of safety will prevent injury, protect your job, and reduce operating costs for your employer. Relate the word accident to terms like broken back, blindness, and death to get it in perspective.

Presentation Outline:

I. Major Factors in Working Safely
   - A. Knowing what the records are
   - B. Recognizing when things are not as they should be
   - C. Attitude towards safety
     1. A state of mind that requires you to accept responsibility for your own and your co-workers safety
     2. A state of mind that does not compromise safety for production or speed
     3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   - A. Preparing to do the job
     1. Research task to insure it can be performed
     2. Appropriate tools and help are available
     3. Proper lockout procedure
   - B. Select appropriate safety equipment
   - C. Once the job starts, maintain a clean work place
   - D. Avoid unsafe practices
     1. Failing to use safety equipment
     2. Performing task you are not qualified to perform
     3. Rushing
     4. Practical joking
     5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   - A. Assume responsibility for your own safety
   - B. Notify crew and supervision of an unsafe condition
   - C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   - A. Working with electricity
   - B. Working near rotating equipment
   - C. Working with chemicals and solvents
   - D. Using pneumatic or hydraulic equipment
   - E. Using ladders
   - F. Lifting heavy objects
   - G. Working in areas with harmful fumes

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A3) dealing with working aloft.

IMM-A2-HO
Accident Prevention
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.
5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.

FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

- ☐ No make shift wiring
- ☐ Extension cords serviceable
- ☐ Motors and tools free of dirt and grease
- ☐ Lights clear of combustible materials
- ☐ Safest cleaning solvents used
- ☐ Fuse and control boxes clean and closed
- ☐ Circuits properly fused
- ☐ Equipment approved for use in hazardous areas (if required)
- ☐ Ground connection clean and tight

FRICTION

- ☐ Machinery properly lubricated
- ☐ Machinery properly adjusted and aligned

SPECIAL FIRE-HAZARD MATERIALS

- ☐ Special isolation of flammable materials
- ☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

- ☐ Areas surveyed for fire safety
- ☐ Combustibles removed or covered
- ☐ Permit issued

OPEN FLAMES

- ☐ Kept away form spray rooms and booths
- ☐ Portable torches clear of flammable surfaces
- ☐ No gas leaks

PORTABLE HEATERS

- ☐ Set up with ample horizontal and overhead clearances
- ☐ Secured against tipping or upset
- ☐ Combustibles removed or covered
- ☐ Safely mounted on noncombustible surface
- ☐ Not used as rubbish burners

HOT SURFACES

- ☐ Hot pipes clear of combustible materials
- ☐ Ample clearance around boilers and furnaces
- ☐ Soldering irons kept off combustible surfaces
- ☐ Ashes in metal containers

SMOKING AND MATCHES

- ☐ "No smoking" and "smoking" areas clearly marked
- ☐ Butt containers available and serviceable
- ☐ No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION

- ☐ Flammable waste material in closed metal containers
- ☐ Flammable waste material containers emptied frequently
- ☐ Piled material cool, dry, and well ventilated
- ☐ Trash receptacles emptied daily

STATIC ELECTRICITY

- ☐ Flammable liquid dispensing vessels grounded or banded
- ☐ Moving machinery grounded
- ☐ Proper humidity maintained

HOUSEKEEPING

- ☐ No accumulations of rubbish
- ☐ Safe storage of flammables
- ☐ Passageways clear of obstacles
- ☐ Premises free of unnecessary combustible materials
- ☐ No leaks or dripping of flammables and floor free of spills
- ☐ Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT

- ☐ Proper type
- ☐ In proper location
- ☐ Unobstructed
- ☐ Clearly marked
- ☐ In working order
- ☐ Service date current
- ☐ Personnel trained in use of equipment

Module Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
      1. Recognizing when things are not as they should be
   B. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your coworkers' safety
      2. A state of mind that does not compromise safety for production or speed
      3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   A. Preparing to do the job
      1. Research task to insure it can be performed
      2. Appropriate tools and help are available
      3. Proper lockout procedure
   B. Select appropriate safety equipment
   C. Once the job starts, maintain a clean work place
   D. Avoid unsafe practices
      1. Failing to use safety equipment
      2. Performing task you are not qualified to perform
      3. Rushing
      4. Practical joking
      5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   A. Assure responsibility for your own safety
   B. Notify crew and supervision of an unsafe condition
   C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   A. Working with electricity
   B. Working near rotating equipment
   C. Working with chemicals and solvents
   D. Using pneumatic or hydraulic equipment
   E. Using ladders
   F. Lifting heavy objects
   G. Working in areas with harmful fumes

Name:_____ Date:_____

IMM-A2
Accident Prevention
Self-Assessment

1. List two major factors in working safely.
   _____
   _____

2. List four steps that help insure a safe job.
   _____
   _____
   _____
   _____

3. Safety is _____ responsibility.

4. List four tasks that have the potential to cause injury.
   _____
   _____
   _____
   _____

5. One of the most important factors in personal safety is _____.

IMM-A2
Accident Prevention
Self-Assessment Answer Key

1. Knowing what the hazards are and how to avoid them. Right attitude towards safety.

2. a. Be alert to unsafe condition
   b. Observe and recognize unsafe condition
   c. Decide how to handle situation safely
   d. Take necessary precaution to avoid injury

3. Your

4. a. Not right safety attitude
   b. Not obeying safety rules
   c. Not following safety procedure
   d. Not using PPE

5. Attitude

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A3

Subject: Industrial Maintenance **Time: 5 Hrs.**

Duty: Practice Safety
Task: Working Aloft

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Instructional Materials:

Safety Belt
Extension Ladder
Hard Hat (Instructor's Discretion)
Safety Glasses
MASTER Handout (IMM-A3-HO)
MASTER Laboratory Aid (IMM-A3-LA)
MASTER Laboratory Worksheet (IMM-A3-LW)
MASTER Self-Assessment

References:

29 CFR 1910.25,26

29 CFR 1910.66

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual

System, 1151 Boston -Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965),* Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, D.C. 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Ladder Safety, - 2:58m - Video Tape - Summit Training Source, Inc., 620 Three Mile Rd, N.W. Grand Rapids, MI 49504, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"
IMM-A2 "Accident Prevention"

Introduction:

All maintenance technicians have to work aloft occasionally. This may be safely done if the technician is familiar with industry and OSHA regulations. An attitude of safety, the correct safety equipment, and proper training are all essential.

Presentation Outline:

I. Identify Safety Equipment Used When Working Aloft
   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA's rules
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

III. Basic Safety Concerns While Working from Scaffolding
   Note: This module does not address scaffolding erection because special training is required
   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Manlift or Personnel Lift (see 29 CFR 1910.68)
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to [illegible]mber designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-A3-LW) and turn in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objective as a guide. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A4) dealing with fire safety.

IMM-A3-HO
Working Aloft
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

Chapter	Title
9	Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

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Module Outline:

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
A. Equipment common to most personnel when working aloft
1. Safety glasses

2. Hard hat
3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

IMM-A3-LA
Working Aloft
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

IMM-A3-LW
Working Aloft
Attachment 3: **MASTER** Laboratory Worksheet

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
Note: This module does not address scaffolding erection because special training is required
   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance

B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

Name_____ Date_____

IMM-A3
Working Aloft
Self-Assessment

1. A ladder with a 250 lb. weight capacity for heavy duty use is considered:
   a. Type IA
   b. Type I
   c. Type II
   d. Type III

2. An aluminum ladder can be used near electrical sources if it has rubber feet on the bottom.
   a. True
   b. False

3. How far must a ladder extend beyond the roof line if you are going to climb onto the structure?
   a. 1 foot
   b. 3 feet
   c. 10 feet
   d. None of the above

4. The base of a ladder should be placed so that it is one foot away from the structure for every four feet of height to the point where the ladder rests against the building?
   a. True
   b. False

5. A ladder whose top support points is 12 feet high should be how far from the structure?
   a. 2 feet
   b. 3 feet
   c. 4 feet
   d. None of the above

6. A step ladder can be leaned against a structure if it is secured at the bottom.
   a. True
   b. False

7. How often should a ladder be inspected?
   a. Once a month by maintenance personnel only
   b. Only if it has been dropped
   c. Before each use
   d. None of the above

IMM-A3
Working Aloft
Self-Assessment Answer Key

1. b
2. b
3. b
4. a
5. b
6. a
7. c

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A4

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Practice Safety
Task: Fire Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technician's responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Instructional Materials:

Dust Mask
Gloves
Face Shields
Side Shields
Outside space appropriate for controlled fire
Adequate extinguishers to use for practice
Emergency extinguishers for correct class of the fire
MASTER Handout (IMM-A4-HO)
Reading assignment in 29 CFR 1910.155 and 29 CFR 1910.157
MASTER Laboratory Aid (IMM-A4-LA)
MASTER Laboratory Worksheet (IMM-A4-LW)
MASTER Self-Assessment

References:

29 CFR 1910.155

29 CFR-1910.157

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, Iowa, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and ***Standards and Recommended Practices,*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Fire Fighting Equipment - 15m - Video Tape - (Akron), Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"
IMM-A2 "Accident Prevention"
IMM-A3 "Working Aloft"

Introduction:

This module will provide you with the knowledge to prevent fires, and teach you how to react in the event of a fire and how to operate an extinguisher. It is not intended to make you a fire fighter. Each industry has its own procedure for handling fires and that procedure should become part of this module prior to teaching.

Working in Areas With Harmful Fumes:

In the operation of welding and cutting, toxic materials are given off in the form of smoke and other gases. Work areas in which this type of work is done must be well ventilated to prevent inhalation of toxic fumes and to prevent the possibility of oxygen deficiency. Certain metals, fluxes, and cleaning compounds are inhalation hazards. These include fluorine, lead, zinc, iron oxide, beryllium, cadmium, and mercury. If you doubt that ventilation is adequate, discontinue welding or cutting which involves these materials.

Presentation Outline:

I. Technician's Responsibility
   - A. Each employer will have company specific rules
   - B. Unless the technician is part of the company fire fighting crew or fire brigade
     1. Notify every one in the area to evacuate
     2. Get to a phone and notify appropriate department
     3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
     4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   - A. Fuel
   - B. Oxygen
   - C. Heat

III. Four Classes of Fire
   - A. Ordinary combustibles
   - B. Flammable liquids
   - C. Electrical
   - D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   - A. Careless smokers
   - B. Electrical overloads
   - C. Inadequate fire watch for welding and cutting operations
   - D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Practical Application:

Students will practice under instructor supervision using the correct extinguisher and extinguishing a fire. Each student will select, check, and use the appropriate extinguisher to put out a fire.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the readout (IMM-A4-HO). Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A5) dealing with lifting safety.

IMM-A4-HO
Fire Safety
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

Chapter	Title
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

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Module Outline:

I. Technician's Responsibility

A. Each employer will have company specific rules
B. Unless the technician is part of the company fire fighting crew or fire brigade
    1. Notify every one in the area to evacuate
    2. Get to a phone and notify appropriate department
    3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
    4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
    A. Fuel
    B. Oxygen
    C. Heat

III. Four Classes of Fire
    A. Ordinary combustibles
    B. Flammable liquids
    C. Electrical
    D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
    A. Careless smokers
    B. Electrical overloads
    C. Inadequate fire watch for welding and cutting operations
    D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Fire Extinguisher
Agent Characteristics

Suitable for use on what type of fire: B C

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an "A" rating; however, they are designated as having "A" capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea

Average Size - 2 to 30 lbs. (11 to 23)
Horizontal Range - 5 to 20 ft. (15 to 30)
Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing

Average Size - 2 ½ to 20 lbs.
Horizontal Range - 3 to 8 ft.
Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing

Average Size - 2 ½ lbs.
Horizontal Range - 4 to 8 ft.
Discharge Time - 8 to 10 sec.

Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.

IMM-A4-LA
Fire Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

IMM-A4-LW
Fire Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standard of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers

Name_____ Date_____

IMM-A4
Fire Safety
Self-Assessment

Answer the following questions by circling the correct answer.

1. Conditions required for a fire to exist:
   a. Fuel, Hydrogen, Heat
   b. Hydrogen, Oxygen, Fuel
   c. Heat, Hydrogen, Oxygen
   d. Fuel, Oxygen, Heat

2. Four classes of fire are:
   _____
   _____
   _____
   _____

3. List four typical causes of workplace fires:
   _____
   _____
   _____
   _____

4. A Class _____ fire extinguisher is used for electrical fires.

5. A Class _____ fire extinguisher is used for ordering combustibles fires.

IMM-A4
Fire Safety
Self-Assessment Answer Key

1. b

2. Four classes of fire are:
   a
   b
   c
   d

3. List four typical causes of workplace fires:
   combustibles
   flammable liquids
   electrical equipment
   combustible metals

4. C

5. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A5

Subject: Industrial Maintenance **Time: 3 Hrs.**

Duty: Practice Safety
Task: Lifting Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Instructional Materials:

Large Empty Cardboard Box
Pencil
Paper
Gloves
Safety Glasses
Hand Truck
Conveyor
Chains
Sling
Face Shield
Side Shield
MASTER Handout (IMM-A5-HO)
MASTER Laboratory Worksheet (IMM-A5-LW)
MASTER Laboratory Aid (IMM-A5-LA)
Copy of 29 CFR 1910 Regulations

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data,* Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, IA, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and *Practice for Industrial Lighting (ANSI A11.1-1965),* Laminating Engineering Society , 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC, 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Supervisor's Safety Manual, Latest Edition

Mechanics' and Millwrights' Guide, Carl Nelson, Audel Publishers, Latest Edition

Maintaining a Healthy Back, - 15m - Video Tape - Ergodyne Corp., Latest Edition

Lifting, Eye Protection and Hand Tool Safety, - 20m - Video Tape - BBP, Latest Edition

Rigging, - Video Tape - ITS - Video Tape, Latest Edition

Basic Injury Prevention, - C.L.M. - Video Tape, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"
IMM-A2 "Accident Prevention"
IMM-A3 "Working Aloft"
IMM-A4 "Fire Safety"

Introduction:

Injuries resulting from improper lifting probably are the number one cause of employee injury. A strong physically fit body is not enough to ensure you won't have back problems. Following time proven lifting methods and getting help when you need it is your best assurance. Remember you are responsible for your own safety. Furthermore, moving a load safely to protect the load, hoist, person operating the hoist, and other people is very important.

Presentation Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet
II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.

H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.

III. Consequences of Improper Lifting
- A. Injury
- B. Loss time
- C. Possibility of becoming unemployed

IV. When Is It Unsafe to Lift an Object Alone
- A. Bulked load that restricts view
- B. When you would have to lift with your back rather than your legs
- C. When the object is too large to get a good grip

V. Discuss Handling Specific Shapes
- A. Locate center of gravity and use this area to lift
- B. Place as much weight as possible as close to lifting mechanism
- C. Place flat weight on button

VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
- A. Gloves
- B. Safety glasses
- C. Is the object being lifted a hazardous material?

VII. Discuss Equipment for Material Handling
- A. Hand trucks
- B. Powered trucks
- C. Conveyers
- D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
- A. Place most of the weight on bed of hand truck
- B. May require two people if one object is difficult to lift on side
- C. Hold object tightly as handle is pulled back
- D. Adjust handle position so more weight is on hand end
- E. After movement, hold object tightly as handle is moved upward
- F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
- A. Watch out for people
- B. Drive unit slowly
- C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
- A. Watch for pinch points
- B. Exercise caution when loading and unloading objects
- C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
- A. Formula for dealing with center of gravity
- B. Identify parts of hoist
- C. Safely demonstrate using a hoist
- D. Identify types of loads
- E. Discuss and demonstrate lifting techniques

F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings

A. Storage area should be clean and dry

B. Watch for pinch points

C. Inspect for defects before using:

1. Chains
   a. Wear
   b. Stretch
   c. Distortion
   d. Nicks
   e. Cracks
   f. Gauges
2. Slings
   a. Wear
   b. Stretch
   c. Distortion
   d. Flat, Sling Spots

D. Types

1. Slings
   a. Choker
   b. Double Choker
   c. Bridle
   d. Basket
   e. Double Basket

Practical Application:

1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.
3. Students will practice correct lifting techniques.
4. Each student will then complete the Laboratory exercise where he will be graded on demonstrating proper lifting techniques.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the practical evaluation.

Summary:

Review the main lesson points using the Handout (IMM-A5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A6) dealing with lockout/tagout.

IMM-A5-HO
Lifting Safety
Attachment 1: **MASTER** Handout

Standards pf performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Carl Nelson, Audel Publishers, Latest Edition:

Chapter	Title
21	Rigging

Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet
II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.
   H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
III. Consequences of Improper Lifting
   A. Injury
   B. Loss time
   C. Possibility of becoming unemployed
IV. When Is It Unsafe to Lift an Object Alone
   A. Bulked load that restricts view
   B. When you would have to lift with your back rather than your legs
   C. When the object is too large to get a good grip
V. Discuss Handling Specific Shapes
   A. Locate center of gravity and use this area to lift
   B. Place as much weight as possible as close to lifting mechanism
   C. Place flat weight on button
VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
   A. Gloves
   B. Safety glasses
   C. Is the object being lifted a hazardous material?
VII. Discuss Equipment for Material Handling

A. Hand trucks
B. Powered trucks
C. Conveyers
D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people if one object is difficult to lift on side
C. Hold object tightly as handle is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
A. Formula for dealing with center of gravity
B. Identify parts of hoist
C. Safely demonstrate using a hoist
D. Identify types of loads
E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
1. Chains
a. Wear
b. Stretch
c. Distortion
d. Nicks
e. Cracks
f. Gauges
2. Slings
a. Wear
b. Stretch
c. Distortion
d. Flat, Sling Spots
D. Types
1. Slings
a. Choker

b. Double Choker
c. Bridle
d. Basket
e. Double Basket

IMM-A5-LA
Lifting Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

IMM-A5-LW
Lifting Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-A6

Subject: **Industrial Maintenance** **Time: 5 Hrs.**

Duty: **Practice Safety**
Task: Lockout/Tagout

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective Lockout/Tagout procedure;
b. Identify who is allowed to remove or install a Lockout/Tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
d. Determine if all emergency conditions are cleared for maintenance.

Instructional Materials:

Lock (Designed for Lockout)
Safety Tags
Lockout Hasp
Safety Switch
MASTER Handout (IMM-A6-HO)
Relief Valve
Hydraulic Actuated Valve
Safety Sign (caution-lockout for safety before you start)
Valve Lockout
MASTER Self-Assessment
MASTER Laboratory Worksheet (IMM-A6-LW)
MASTER Laboratory Aid (IMM-A6-LA)
Copy of 29 CFR 1910.147 Regulations

References:

OSHA Lockout/Tagout Guidelines, 29 CFR 1910.147

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, IA, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and ***Standards and Recommended Practices,*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

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Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1	"Use Protective Equipment"
IMM-A2	"Accident Prevention"
IMM-A3	"Working Aloft"
IMM-A4	"Fire Safety"
IMM-A5	"Lifting Safety"

Introduction:

This module is designed to teach the purpose and importance of ensuring that the concepts of personal and group safety are not just concepts. Safety must be a way of life if work is to be performed without injury or loss. Think of Lockout/Tagout as life and health assurance. Lockout/Tagout procedures are required by OSHA.

Presentation Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduced employee injuries and death
   B. Reduced down time
   C. Increased awareness of the employees' role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 910.147

II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will vary among industrial clearance procedures.

III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is responsible for briefing the crew as to the clearance boundaries and what is locked out

IV. Locking out or Clearing a Piping, Mechanical System, or Component for Maintenance
   A. Identify typical sources of force that may be present in a typical piping system
      1. Static head pressure or induced thermal pressure
      2. In-line accumulators
      3. Non-insulated automatic actuating valves, motors, or relief
      4. System pressure
      5. Stress that any or all of these forces have the ability to injure or kill if not properly cleared and depressurized prior to maintenance
   B. Methods of relieving trapped pressure from a system or component
      1. Vent and drain valves
      2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
      3. Open system relief valve
   C. Identify typical methods of disabling components prior to maintenance
      1. Manual valves
      2. Pneumatic valves (fail-open or closed)
      3. Hydraulic valves
      4. Relief valves
      5. Fans
      6. Rollers
   D. Energy sources can take many forms, including:
      1. Electrical
      2. Pneumatic
      3. Hydraulic
      4. Mechanical

5. Fluid and gas
6. Thermal
7. Pressurized water
8. Gravity

E. Accidental start-up or release of stored energy can sometimes be controlled with safety devices. Some examples are:
1. Machine guards
2. Electrical disconnects
3. Mechanical stops
4. Point-of-operation guards

Practical Application:

Students will practice correct lockout/tagout procedures. Each student will complete the laboratory exercise and will be graded on demonstrating proper lockout/tagout procedure.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluations.

Summary:

Review the main lesson points using the Handout (IMM-A6-HO) as a guide for discussion and practice lockout/tagout procedures.

Next Lesson Assignment:

MASTER Technical Module (IMM-B1) dealing with performing basic arithmetic functions.

Glossary:

Affected Employee

An employee whose job requires him/her to operate or use a machine or equipment on which service or maintenance is being performed under lockout/tagout, or whose job requires him/her to work in an area in which such service ir maintenance is being performed. Affected employees must be informed when lockout/tagout is being performed.

Authorized Employee

A person who locks and tags machines or equipment in order to perform service or maintenance on that machine or equipment.

Blanks

Typically, a metal disk that is inserted into the space between two pipe flanges. The blank is then bolted in place and forms a solid block to prevent the passage of liquids or gases through the pipe. "Blanking" (the insertion of blanks) is an important step to assure the safe entry into tanks or vessels if the materials in the pipes pose a hazard to employees working inside.

Bleed

Releasing stored hydraulic, electrical or pneumatic energy.

Block-Out

Physically preventing the movement of machinery or equipment using mechanical devices such as blocks, chains, cribbing or timbers.

Capable of Being Locked Out

An energy isolating device is capable of being out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device or permanently alter its energy control capability.

Energized

Connected to an energy source or containing residual or stored energy.

Energy

All sources of power to a given piece of machinery or equipment. These can be electrical, pneumatic, hydraulic, process fluids and gases and mechanical.

Energy Control

The use of energy isolating devices to block or isolate energy sources, as well as Lockout/Tagout procedures to prevent unexpected start-up and release of stored energy during maintenance or installation.

Energy Isolating Device

A mechanical device that physically prevents the transmission or release of energy, including a manually operated electrical circuit breaker, a disconnect switch, a line valve, a block or any similar device used to block or isolate energy.

Energy Source

Any source of electrical, pneumatic, hydraulic, mechanical, thermal, chemical or other energy.

Lockout

The process used to identify, cut off and secure all energy sources before beginning repairs, adjustments or maintenance. A lockout device is used to secure equipment or machinery in the off position, ensuring that the equipment or machinery cannot be operated.

Lockout Device

A lock (either key or combination type) that holds an energy isolating device in a safe position and prevents the machine or equipment or machinery cannot be operated.

Normal Production Operations

The use of a machine or equipment to perform its intended production function.

Servicing and/or Maintenance

Workplace activities that require lockout/tagout on the equipment before beginning the activity because employees may be exposed to the unexpected energized or startup of the equipment or the release of hazardous energy. Servicing and/or maintenance includes constructing, installing, setting up, adjusting, inspecting, modifying, lubricating, cleaning and making tool changes.

Setting Up

Any work performed to prepare a machine or equipment to perform its normal production operation.

Tagout

Attaching a tag to the lock on the power source that has been shut off, indicating the time, reason for the lockout and the name of the person doing the work. The tag acts as a warning not to restore energy to the equipment or machinery.

Tagout Device

A prominent warning tag which can be surely fastened to an energy isolating device to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Written Energy Control Program

This is the main requirement of the OSHA Standard. The written program provides details about:

1. The hazards of uncontrolled energy;
2. Energy control and lockout/tagout procedures in the workplace;
3. Employee training;
4. Inspections; and,
5. Complete records of all inspection and training that applies to energy control and lockout/tagout.

Zero Energy State

All energy has been controlled in machinery or equipment.

IMM-A6-HO
Lockout/Tagout
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency condition are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness pf employees role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147
II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between industry clearance procedures.
III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.

C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
   1. Static head pressure or induced thermal pressure
   2. Incline accumulators
   3. Unisolated automatic actuating valves, motors or relief
   4. System pressure
   5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
   1. Vent and drain valves
   2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
   3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
   1. Manual operated valves
   2. Pneumatic operated valves (fail open or closed)
   3. Hydraulic actuated valve
   4. Relief valves
   5. Fans
   6. Rollers

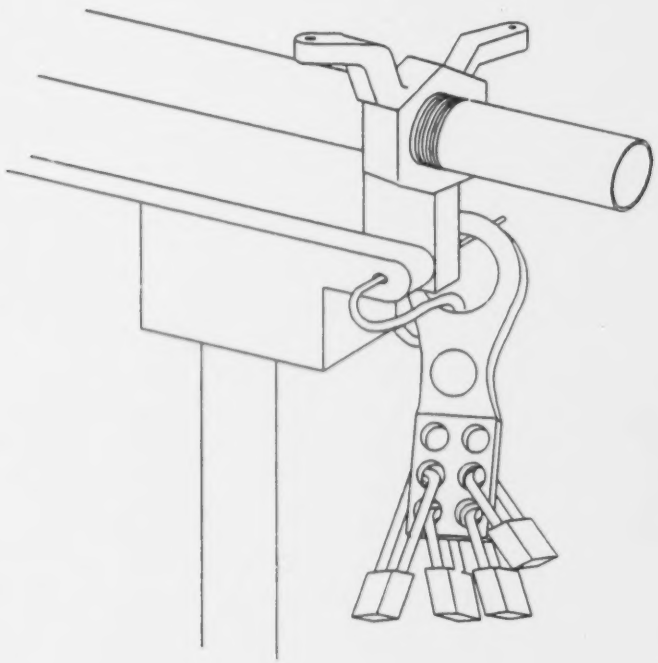
Reading Assignments:

Read the handout titled "Lockout and Tagout Procedures."

Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

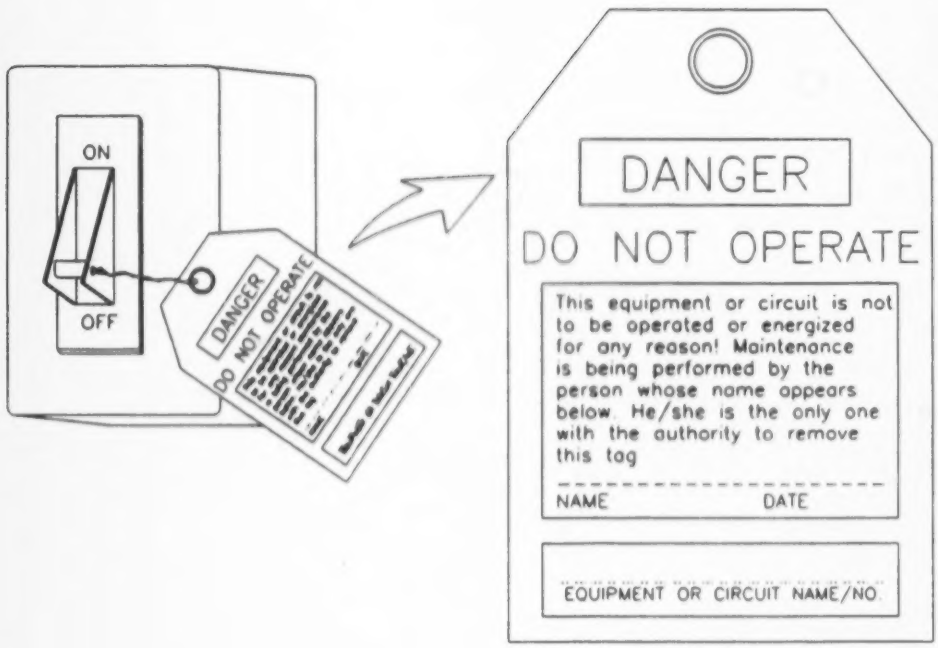
To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.



1 - A Lockout Device

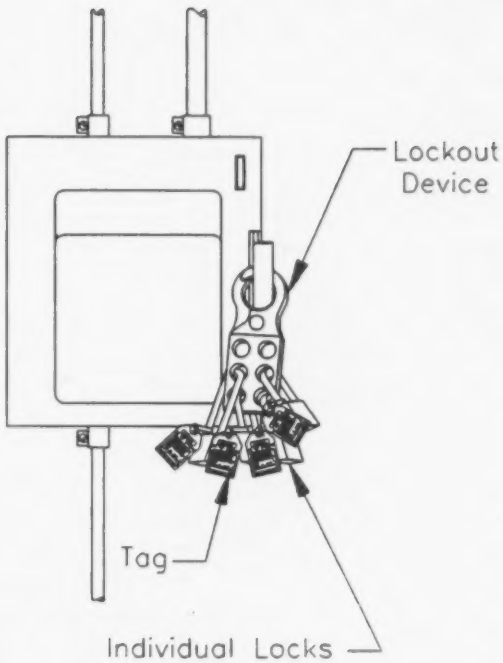
Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.


ON
OFF
DANGER
DO NOT OPERATE
DANGER
DO NOT OPERATE
This equipment or circuit is not to be operated or energized for any reason! Maintenance is being performed by the person whose name appears below. He/she is the only one with the authority to remove this tag
NAME
DATE
EQUIPMENT OR CIRCUIT NAME/NO.

2 - Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.



3 - Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.

Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-A6-LW
Lockout/Tagout
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.

Name_____ Date_____

IMM-A6
Lockout/Tagout
Self-Assessment

1. The term Lockout is best defined as:
   a. Blocking the flow of energy from a power source to a piece of equipment.
   b. Shutting down a piece of equipment for service or maintenance work.
   c. Applying a lock to a piece of equipment to show that it should not be used.
   d. Applying a tag to a piece of equipment to show that it should not be used.

2. A Lockout procedure is used whenever:
   a. The servicing or repair work to be done places an employee in danger.
   b. An equipment guard must be removed for servicing.
   c. A power source can be locked out for servicing.
   d. All of the above.

3. Tagout refers to :
   a. The warning tag attached to a power source or piece of machinery telling others not to restart.
   b. The process of blocking energy form reaching a piece of equipment.
   c. Signing off that a certain piece of machinery has been serviced.
   d. A device that physically prevents others from restarting equipment.

4. An authorized employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Services machinery that is subject to lockout.
   c. Actually locks out equipment for servicing.
   d. Both b and c.

5. An affected employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Works in an area where lockout is used.
   c. Services machinery that is subject to lockout.
   d. Both a and b.

6. Zero energy state refers to:
   a. A power source that is locked out for servicing.
   b. A power source that is locked out and tagged for servicing.
   c. The release of all stored energy from a power source.
   d. The release of all locks and tags so that energy can be restored.

7. It is all right to lend your lock to a co-worker if:
   a. The co-worker's lock is in another part of the building.
   b. The co-worker's lock is in another building miles away from where he is working.
   c. You know you won't be using your lock.
   d. None of the above.

8. If you come across a piece of equipment that is turned off but not locked out, you would:
   a. Ask someone working in the area if it could be turned back on.
   b. Notify someone who is authorized to perform lockout.
   c. Never restart the equipment.
   d. Both b and c.

9. A lockout audit must be performed by:
   a. An authorized person who works with the lockout procedure to be inspected,
   b. An authorized person who doesn't work with the lockout procedure to be inspected.
   c. A person from the Health and Safety department.
   d. None of the above.

10. Lockout/Tagout procedures are in place to:
   a. Prevent the accident start-up of equipment.
   b. Prevent workers from taking short-cuts while servicing equipment.
   c. To be used when startup occurs.
   d. To be used when the machine is stopped.

11. The _____ physically prohibits the operation of a piece of equipment.
   a. GFCI
   b. tagout device
   c. lockout device
   d. a, b, and c

12. The _____ does not physically prohibit operation of equipment; it relies on those who relies on those who read it.
   a. GFCI
   b. tagout device
   c. lockout device
   d. a, b, and c

13. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
   a. true
   b. false

14. Under normal operating conditions, in addition to you, who is allowed to remove your padlock form a machine's power source after a power lockout?
    a. no one
    b. The maintenance supervisor
    c. the safety engineer
    d. your supervisor

15. This organization establishes, implements, and enforces safe workplace guidelines.
    a. NEC
    b. ANSI
    c. OSHA
    d. NEMA
    e. UL
    f. UAW

IMM-A6
Lockout/Tagout
Self-Assessment Answer Key

1. b
2. d
3. a
4. d
5. b
6. c
7. d
8. d
9. a
10. a
11. c
12. b
13. a
14. a
15. c

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW)	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-B1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B1

Subject: Industrial Maintenance **Time:** 1 Hr.

Duty: Apply Mathematical Concepts
Task: Perform Basic Arithmetic Functions

Objective(s):

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals; and,
h. Divide decimals.

Instructional Materials:

Paper
Pencil
Overhead Projector
Chalkboard
MASTER Handout (IMM-B1-HO)
MASTER Laboratory Worksheet (IMM-B1-LW)
MASTER Self-Assessment

References:

Applied Electronic Math, with calculators, John W. Tontsch, Latest Edition

Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition

Basic Electronics Math With A Scientific Calculator, by Edward M. Noll, Latest Edition

Becoming A Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success In Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition

Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-A6 "Lockout/Tagout"

Introduction:

Basic math skills are used daily in many areas of our lives. These skills are used in work and home. This area of math is the most popular area used today.

Presentation Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Add Decimals
VI. Subtract Decimals
VII. Multiply Decimals
IX. Divide Decimals

Practical Application:

Students will practice working math problems. Each student will complete the **MASTER** Laboratory Worksheet (IMM-B1-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objections as a guide and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B2) dealing with the conversion of fractions and decimals.

IMM-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate math skills acquired in this module by:
Actively participating in class; and,
Working problems in this module;

Objectives:

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals;
h. Divide decimals;
i. Locate any decimal place to the millionths;
j. Read numbers containing decimals;
k. Write numbers containing decimals;
l. Round off a decimal to a specified place value;
m. Align decimal points before computation;
n. Add numbers containing decimals;
o. Subtract numbers containing decimals;
p. Multiply numbers containing decimals; and,
q. Divide numbers containing decimals.

Module Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Decimal System Place Value
VI. Add Decimals
VII. Subtract Decimals
VIII. Multiply Decimals
IX. Divide Decimals

IMM-B1-LW
Perform Basic Arithmetic Functions
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

Give the place value of the 5 in the numbers below:

1. 16.53 _____
2. 0.4565 _____
3. 51,345 _____

Write the numbers below in words:

4. 0.000052 _____
5. 0.013 _____
6. 0.0008 _____
7. 15,248 _____

Write the numbers that are indicated by the following phrases:

8. Three thousandths _____
9. Seventy-five and sixty seven hundredths _____
10. Eighty-six hundred ten-thousandths _____

Round these numbers to the specified place value:

		Thousandths	Tenths	Hundredths
11.	2.75	_____	_____	_____
12.	18.613	_____	_____	_____
13.	0.22	_____	_____	_____

14. 14.2343 _____ _____ _____

15. When adding or subtracting decimals, be sure the decimal points are _____.

Add or subtract the following:

16. 0.7 + 14 + 16.2 = _____

17. 74 + 890 + 0.0057 - 46.72 = _____

18. 42.6 + 0.0131 = _____

19. It is not necessary to align the _____ _____ in a multiplication problem.

20. The number of digits behind a decimal point in the _____ equals the number of digits behind decimal points in the _____ _____ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.

21. 254.8 x 14 = _____

22. 6,000 x 0.021 = _____

23. 152.33 x 3.5 = _____

24. 16.8 x 101.6 = _____

25. To multiply a number by a multiple of 10, simply count the number of zeros in the _____ and move the decimal point in the _____ the same number of places.

Use the short cut method to solve the following problems:

26. 15.1 x 10,0001 = _____

27. 0.44 x 102 = _____

Solve the following problems, using zeros as place holders if necessary:

28. 6099.6 divided by 16.5 = _____

29. 1509.04 divided by 2.3 = _____

30. When dividing by a multiple of 10, move the decimal point to the _____ the same number if spaces as there are zeros in the _____.

Use the short cut method of dividing by multiples of 10 to solve the following problems:

31. 0.053 divided by 1000 = _____

32. 14.954 divided by 10 = _____

33. 110 divided by 1000 = _____

34. 436.89 divided by 100 = _____

Name:_____ Date:_____

IMM-B1
Perform Basic Arithmetic Functions
Self-Assessment

Give the place value of the 5 in the numbers below:

1. 16.52 _____

2. 0.4566 _____

3. 51,346 _____

Write the numbers below in words:

4. 0.000051 _____

5. 0.011 _____

6. 0.0007 _____

7. 15,247 _____

Write the numbers that are indicated by the following phrases:

8. Two thousandths _____

9. Sixty-five and sixty seven hundredths _____

10. Eighty-seven hundred ten-thousandths _____

Round these numbers to the specified place value:

		Thousandths	Tenths	Hundredths
11.	2.76	_____	_____	_____
12.	18.614	_____	_____	_____
13.	0.23	_____	_____	_____
14.	14.2345	_____	_____	_____

15. When adding or subtracting decimals, be sure the decimal points are _____.

Add or subtract the following:

16. 0.7 + 14 + 16.1 = _____

17. 74 + 890 + 0.0051 - 46.72 = _____

18. 42.6 + 0.0132 = _____

19. It is not necessary to align the _____ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.

20. 254.8 x 13 = _____

21. 6,000 x 0.020 = _____

22. 152.33 x 3.6 = _____

23. 16.8 x 101.7 = _____

24. To multiply a number by a multiple of 10, simply count the number of zeros in the _____ and move the decimal point to the _____ the same number of places.

Use the short cut method to solve the following problems:

25. 15.1 x 10,0000 = _____

26. 0.44 x 100 = _____

Solve the following problems, using zeros as place holders if necessary:

27. 6099.6 divided by 16.6 = _____

28. 1509.04 divided by 2.4 = _____

29. When dividing by a multiple of 10, move the decimal point to the _____ the same number if spaces as there are zeros in the _____.

Use the short cut method of dividing by multiples of 10 to solve the following problems:

30. 0.052 divided by 1000 = _____

31. 14.953 divided by 10 = _____

32. 100 divided by 1000 = _____

33. 436.86 divided by 100 = _____

IMM-B1
Perform Basic Arithmetic Functions
Self-Assessment Answer Key

1. Tenths

2. Hundredths

3. Ten thousandths

4. Fifty one millionths

5. Eleven thousandths

6. Seven ten thousandths

7. Fifteen thousand, two hundred forty seven

8. .002

9. 65.67

10. .8700

11. 2.760 (thousandths)
    2.8 (tenths)
    2.76 (hundredths)

12. 18.614 (thousandths)
    18.6 (tenths)
    18.61 (hundredths)

13. 0.230 (thousandths)
    0.2 (tenths)
    0.23 (hundredths)

14. 14.235 (thousandths)
    14.2 (tenths)
    14.23 (hundredths)

15. In a vertical line

16. 30.8

17. 917:2851

18. 42.6132

19. Numbers

20. 3312.4

21. 120

22. 548.388

23. 1708.56

24. Number, right

25. 151,000

26. 44

27. 367.44578

28. 628.76666

29. Left, number

30. .000052

31. 1.4953

32. 0.1

33. 4.3686

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B2

Subject: Industrial Maintenance **Time: 6 Hrs.**

Duty: Apply Mathematical Concepts
Task: Convert Fractions/Decimals

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;
b. Reduce fractions to their lowest terms;
c. Define prime number and composite number;
d. Define common fractions and uncommon fractions;
e. Add fractions;
f. Find the common denominator of a number of fractions;
g. Subtract fractions;
h. Define mixed number;
i. Define improper fractions;
j. Change mixed numbers to improper fractions;
k. Change improper fractions to mixed numbers;
l. Reduce improper fractions to their lowest terms;
m. Add improper fractions;
n. Subtract improper fractions;
o. Multiply fractions; and,
p. Divide fractions.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (IMM-B2-HO)
MASTER Laboratory Worksheet (IMM-B2-LW)
MASTER Self-Assessment
Textbook

References:

Applied Electronic Math, with Calculators, John W. Tontsch, Latest Edition

Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition

Basic Electronics Math with a Scientific Calculator, by Edward M. Noll, Latest Edition

Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition

Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-B1 "Perform Basic Arithmetic Functions"

Introduction:

This module prepares you to use fractions. Many calculations made in industrial plants use fractions. Fractions allow you to measure and adjust tolerances on machinery parts. Working with blueprints or machine parts specifications also requires an understanding of fractions.

In this module you will learn how to add, subtract, multiply and divide fractions. Also, you will learn how to work with mixed numbers that combine whole numbers and fractions. Fractions are converted to decimals and decimals are converted to fractions.

Presentation Outline:

I. Introduction - Define Fractions
II. Reducing a Fraction
III. Adding Fractions

IV. Subtracting Fractions
V. Improper Fractions
VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-B2-LW) and turn it into the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points and practice laboratory worksheet as a guide.

Next Lesson Assignment:

MASTER Technical Module (IMM-B3) dealing with the conversion of Metric/English measurements.

IMM-B2-HO
Convert Fractions/Decimals
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate ability to work with fractions, convert fractions to decimals, and decimals to fractions.

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;
b. Reduce fractions to their lowest terms;
c. Define prime number and composite number;
d. Define common fractions and uncommon fractions;
e. Add fractions;
f. Find the common denominator of a number of fractions;
g. Subtract fractions;
h. Define mixed number;
i. Define improper fractions;
j. Change mixed numbers to improper fractions;
k. Change improper fractions to mixed numbers;
l. Reduce improper fractions to their lowest terms;
m. Add improper fractions;
n. Subtract improper fractions;
o. Multiply fractions; and,
p. Divide fractions.

Reading Assignments:

The following chapters are assigned to read from ***Math for Consumers***, by D.S. Kaine and L.S. Kaine, Addison-Wesley Pub. Co., Latest Edition:

Chapter	**Title**
	Fractions and Operations

Module Outline:

I. Introduction - Define Fractions
II. Reducing Fractions
III. Adding Fractions
IV. Subtracting Fractions
V. Improper Fractions

VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means "equal to" but not necessarily "identical to."

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.

IMM-B2-LW
Convert Fractions/Decimals
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

Reduce the following fractions to their lowest terms:

1. 4/24 = _____
2. 8/32 = _____
3. 2/18 = _____
4. 36/72 = _____
5. 10/16 = _____

Change the mixed numbers to improper fractions.

1. 9 3/4 = _____
2. 5 7/8 = _____
3. 4 9/32 = _____

Solve the following problems.

1. 2/7 x 6/11 = _____
2. 5/9 x 8/3 = _____
3. 2/3 x 1/10 = _____
4. 5/7 divided by 2/3 = _____
5. 7/8 divided by 1/4 = _____
6. 3/4 divided by 2/9 = _____

Convert decimals to fractions or fractions to decimals.

1. 12/15 = _____

2. 3/5 = _____

3. 11/17 = _____

4. 0.6 = _____

5. 0.875 = _____

6. 0.88 = _____

Name:_____ Date:_____

IMM-B2
Convert Fractions/Decimals
Self-Assessment

Reduce fractions to lowest terms.

1. 0.375 = _____
2. 13/15 = _____
3. 6/8 = _____
4. 31/37 = _____
5. 0.667 = _____

Change mixed numbers to improper fractions.

6. 3 15/16 = _____
7. 6 5/6 = _____
8. 1 19/20 = _____
9. 9 2/5 = _____
10. 4 14/15 = _____

Solve the following problems.

11. 2/3 + 4/5 = _____
12. 4 1/3 - 1 8/9 = _____
13. 14/15 x 15/42 = _____
14. 1 9/15 divide by 6 32/45 = _____
15. 1 7/8 x 3 7/9 = _____

Convert decimals to fractions or fractions to decimals.

16. 7/8 = _____

17. 31/32 = _____

18. 14/16 = _____

19. 0.12 = _____

20. 2.875 = _____

IMM-B2
Convert Fractions/Decimals
Self-Assessment Answer Key

1. 0.375
2. 0.867
3. 0.75
4. 0.838
5. 0.667
6. 63/16
7. 41/6
8. 39/20
9. 47/5
10. 74/15
11. 22/15
12. 2 4/9
13. 1/3
14. 36/151
15. 85/12
16. 0.875
17. 0.969
18. 0.875
19. 1/8
20. 2 7/8

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B3

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Apply Mathematical Concepts
Task: Convert Metric/English Measurements

Objective(s):

Upon completion of this module the student will be able to:

a. Name the three basic units of metric-system measurement;
b. Match the six most commonly used metric-system prefixes with their meaning;
c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;
d. Add and subtract metric-system units;
e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and
f. Convert metric units to English units and English units to metric units.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (IMM-B3-HO)
MASTER Laboratory Worksheet (IMM-B3-LW)
MASTER Self Assessment

References:

Applied Electronic Math, with Calculators, Tontsch, John W., Latest Edition

Applied Math,, Bajpai, Avi C.; Bond, Rodney M.; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Moore, Claude S.; Griffin, Bennie L.; Polhamus, Edward C., Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Dansby, Robert L., Latest Edition

Basic Electronics Math with a Scientific Calculator, Noll, Edward M., Latest Edition

Becoming a Mental Math Wizard, Lucas, Jerry, Latest Edition

Building Success in Math, Langbort, Carol R.; Thompson, Virginia H., Latest Edition

Business Math Basics, Swindle, Robert E., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-B2 "Convert Fractions/Decimals"

Introduction:

In today's world economy maintenance mechanics will see more and more equipment and drawings that require use of the metric numbering system. You must be able to convert dimensions from metric to English or English to metric. This study will help keep you above the rest of the skills needed by the modern maintenance technician.

Presentation Outline:

I. English System
II. Metric System
III. Metric Prefixes
IV. Moving Decimal
V. Metric Length
VI. Metric Weight
VII. Metric Volume
VIII. Metric Temperature
IX. Converting English to Metric Units
X. Converting Metric to English

Practical Application:

Students will practice in the lab. Each student will complete the **MASTER** Laboratory Worksheet (IMM-B3-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B4) dealing with performing basic algebraic operations.

IMM-B3-HO
Convert Metric/English Measurements
Attachment 1: **MASTER** Handout

Standards of Performance:

Student shall demonstrate ability to convert English units to metric units and convert metric units to English units.

Objectives:

Upon completion of this module the student will be able to:

a. Name the three basic units of metric system measurement;
b. Match the six most commonly used metric system prefixes with their meaning;
c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;
d. Add and subtract metric-system units;
e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and,
f. Convert metric units to English units and English units to metric units.

Conversion Chart:

Metric to English

Length
1mm = 0.04 in
1 cm = 0.39 in
1 m = 39.37 in = 3.28 ft
1m = 1.09 yd
1 km = 0.62 mi

Weight
1 g = 0.035 oz
1 kg = 2.2 lb

Volume
1 ml = 0.2 tsp
1 l = 1.057 qt

English To Metric

Length
1 in = 2.54 cm
1 ft = 30.48 cm = 0.305
1 yd =0.914 m
1 mi = 1.609 km

Weight
1 oz = 31.103 g
1 lb = 0.453 kg

Volume
1 tsp = 5 ml
1 c = 284 ml
1 qt = 0.946 l
1 gal = 3.785 l

Common abbreviations used above:

c	=	cup
cm	=	centimeter
ft	=	foot
g	=	gram
gal	=	gallon
in	=	inch
kg	=	kilogram
km	=	kilometer
l	=	liter
lb	=	pound
m	=	meter
mi	=	mile
ml	=	milliliter
mm	=	millimeter
oz	=	ounce
qt	=	quart
tsp	=	teaspoon
yd	=	yard

Reading Assignments:

The following chapters are assigned to read from ***Math for Consumers***, by D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Subject - Metric System

Module Outline:

I. English System
II. Metric System
III. Metric Prefixes
IV. Moving Decimal
V. Metric Length
VI. Metric Weight
VII. Metric Volume
VIII. Metric Temperature
IX. Converting English to Metric Units
X. Converting Metric to English

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means "equal to" but not necessarily " identical to".

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.

IMM-B3-LW
Convert Metric/English Measurements
Attachment 2: **MASTER** Laboratory Worksheet

Perform operations, as indicated.

1. There are _____ kilograms in a metric ton.

2. 100.9 g - 74.99 g =_____ g

3. 93.6 cg + 1,189 cg =_____cg

Perform the conversions. Round your answer to two places.

1. 34 g =_____oz

2. 92 cm =_____ft

3. 890 l =_____gal

4. 15 cm =_____in

5. 58.5 kg =_____lbs

Name_____ Date_____

IMM-B3
Convert Metric/English Measurements
Self-Assessment

Compute these metric measurements, then convert into English units. Use the conversion chart.

1. 1.2 kg + 849 g = _____kg = _____lb

2. 84.2 1 - 2,145 ml _____l = _____gal

3. 9.3 m x 490 mm = _____km =_____mi

4. 2,600 hg divided by 456.3 kg = _____g =_____oz

5. 493 ml x 0.33 1 = _____ml = _____qt

6. 43.8 cm + 248 mm = _____m = _____ft

7. 492 g divided by 2.2 kg = _____ mg = _____oz

Convert these English units into metric units. Use the conversion chart.

8. 154 mi =_____km

9. 14.5 c = _____ml

10. 1,983 lb = _____kg

11. 154 yd = _____m

12. 98.5 gal _____l

Convert the following measurements and temperatures.

13. 85° C = _____ F

14. 120 mm = _____m

15. 14 kg = _____ g

16. 59° C = _____ F

17. 2.4 t = _____ kg

18. 6.25 l = _____ ml

19. 27° F = _____ C

20. 0.89 km = _____ cm

IMM-B3
Convert Metric/English Measurements
Self-Assessment Answer Key

1. 2.049kg = 4.51 lb
2. 82.06 l = 21.7 gal
3. .0000049 km = .oo49m
4. .5698 g = 16.28 oz
5. 162,690 ml = 171.96 qt
6. 0.69 m = 2.26 ft
7. 223.6 mg = .0078 oz
8. 247.8 km
9. 4,118 ml
10. 898.3 kg
11. 140.8 m
12. 372.75 l
13. 185 F
14. 0.12 m
15. 14,000 g
16. 138.2 F
17. 2,400 kg
18. 6.250 ml
19. -2.8 C
20. 89,000 cm

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B4

Subject: Industrial Maintenance **Time: 6 Hrs.**

Duty: Apply Mathematical Concepts
Task: Perform Basic Algebraic Operations

Objective(s):

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (IMM-B4-HO)
MASTER Laboratory Worksheet (IMM-B4-LW)
MASTER Self-Assessment

References:

Applied Electronic Math, with Calculators, John W. Tontsch, Latest Edition

Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition

Basic Electronics Math with a Scientific Calculator, by Edward M. Noll, Latest Edition

Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition

Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-B3 "Convert Metric/English Measurements"

Introduction:

This module includes basic techniques used in working with formulas. In this module, you will consider approaches to working formulas. These are methods you can apply whenever you have to use formulas. In this module, you will learn how to substitute values in formulas. You will learn how to use formulas to find various unknowns. You will practice what you learn by working some practical formulas.

Presentation Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Practical Application:

Students will practice in the lab. Each student will complete the **MASTER** Laboratory Worksheet (IMM-B4-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and work problems on MASTER laboratory worksheet.

Next Lesson Assignment:

MASTER Technical Module (IMM-B5) dealing with performing basic trigonometric functions.

IMM-B4-HO
Perform Basic Algebraic Operations
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses ( ) or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.

6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fractions numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity form one side of an equation to the other, you change its sign or operation.

Reading Assignments:

The following chapaters are assigned to read from ***Math for Consumers,*** D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Chapter	**Title**
	Equation Solving

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
A statement that two quantities are equal.

Formula

A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term

Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation

The process of moving a quantity from one side of an equation to the other by changing its sign of operation.

IMM-B4-LW
Perform Basic Algebraic Operations
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

   _____

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

   _____

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

   _____

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.

   _____

Name:_____ Date:_____

IMM-B4
Perform Basic Algebraic Operations
Self-Assessment

1. Rearrange the formula $F_1 \times D_1 = F_0 \times D_0$ to solve for D_1 . (Show all steps.)

_____

_____

2. Rearrange the formula $A = L \times W$ to solve for W. (Show all steps.)

_____

_____

3. Write the sentence that is the equivalent of the formula $A = L \times W$. (A = area of a rectangle, L = Length, and W = width.)

_____

_____

4. Assume that W represents work, F represents force, and D represents distance. Write a formula that shows distance multiplied by force equals work.

_____

_____

5. In a formula, a combination of a number and a letter or two letters, like 3A or BC indicates:
   a. addition
   b. multiplication
   c. either of the above, depending on the sign in the equation.
   d. none of the above

6. Equations are:
   a. formulas
   b. statements of principles
   c. statements that two quantities are equal
   d. all of the above

7. Formulas:
   a. are equations
   b. show how some quantities are related to each other
   c. state relationships which have been tested and proven to be true
   d. all of the above

IMM-B4
Perform Basic Algebraic Operations
Self-Assessment Answer Key

1. $F_1 \times D_1 = F_0 \times D_0$; therefore, $D_1 = (F_0 \times D_0) / F_1$

2. A=LxW; therefore, A/L = W

3. Area of a retangle = Length time width

4. Distance multiplied by force = Work; therefore DxF = W

5. b

6. d

7. d

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B5

Subject: Industrial Maintenance **Time: 50 Hrs.**

Duty: Apply Mathematical Concepts
Task: Perform Basic Trigonometric Functions

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Instructional Materials:

MASTER Handout (IMM-B5-HO)
MASTER Laboratory Worksheet (IMM-B5-LW)
MASTER Self-Assessment
Paper
Pencil
Chalk Board
Overhead Projector

References:

Applied Electronic Math, with calculators, John W. Tontsch, Latest Edition

Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition

Basic Electronics Math with a Scientific Calculator, by Edward M. Noll, Latest Edition

Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition

Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-B4 "Perform Basic Algebraic Operations"

Introduction:

Trigonometry in a study of right triangles. The right triangle is useful in studying angles, arcs, and distances. Proportional control is also a valuable asset.

Presentation Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

Practical Application:

Students will practice working math problems. Each student will complete the **MASTER** Laboratory Worksheet (IMM-B5-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of written evaluation.

Summary:

Review the main lesson points using the **MASTER** Handout (IMM-B5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B6) dealing with basic geometric calculations.

IMM-B5-HO
Perform Basic Trigonometric Functions
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation.;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from *Mathematics for Technicians* by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
9	Trigonometry

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation

VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

IMM-B5-LW
Perform Basic Trigonometric Functions
Attachment 2: MASTER Laboratory Worksheet

Worksheet:

(Use Trig Function Tables)

Solve:

1. Sin 22° 18' = _____
2. Cot 22° 18' = _____
3. Sec 22° 18' = _____
4. Tan 22° 18' = _____
5. Csc 22° 18' = _____
6. Cos 22° 18' = _____
7. Cos A = 0.69675 _____
8. Cot A = 1.1340 _____
9. Sin A = 0.98531 _____
10. Sec A = 1.5753 _____
11. Tan A = 0.50587 _____
12. 2∏ Radians = _____ Degrees
13. 180 Degrees = _____ Radians
14. ∏ Radians = _____ Degrees

Name:_____ Date:_____

IMM-B5
Perform Basic Trigonometric Functions
Self-Assessment

(Use Trig Function Tables)

Solve:

1. 97 Degrees = _____ Radians
2. 1.5 ∏ Radians = _____ Degrees
3. Sin 37° 14' = _____
4. Cos 156° 16' = _____
5. Tan 41° 11' = _____
6. Sec 18° 9' = _____
7. Csc 8° 8' = _____
8. Cot 21° 8' = _____
9. Sec A = 1.5753 _____
10. Sin A = 0.98531 _____

IMM-B5
Perform Basic Trigonometric Functions
Self-Assessment Answer Key

1. 1.69
2. 270
3. 0.6050
4. .55533
5. 0.87492
6. 0.0524
7. 3.2131
8. 0.5871
9. 50° 36°
10. 79° 50°

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-B6

Subject: Industrial Maintenance **Time: 20 Hrs.**

Duty: Apply Mathematical Concepts
Task: Perform Basic Geometric Calculations

Objective(s):

Upon completion of this module the student will be able to demonstrate how to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Instructional Materials:

MASTER Handout (IMM-B6-HO)
MASTER Laboratory Worksheet (IMM-B6-LW)
MASTER Self-Assessment
Paper
Pencil
Chalk Board
Overhead Projector
Various Geometric Objects

References:

Applied Electronic Math, with Calculators, Tontsch, John W., Latest Edition

Applied Math, Bajpai, Avi C.; Bond, Rodney M.; adapted by Jerry W. Jones, Latest Edition

Applied Math for Technicians, Moore, Claude S.; Griffin, Bennie L.; Polhamus, Edward C., Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Dansby, Robert L., Latest Edition

Basic Electronics Math with a Scientific Calculator, by Noll, Edward M., Latest Edition

Becoming a Mental Math Wizard, Lucas, Jerry, Latest Edition

Building Success in Math, Langbort, Carol R.; Thompson, Virginia H., Latest Edition

Business Math Basics, Swindle, Robert E., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-B1 "Perform Basic Arithmetic Functions"
IMM-B4 "Perform Basic Algebraic Operations"

Introduction:

Geometry is used to calculate lengths, angles, arcs, area and volumes of various shapes and objects.

Presentation Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism

Practical Application:

Students will practice working math problems. Each student will complete the **MASTER** Laboratory Worksheet (IMM-B6-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the handout (IMM-B6-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C1) dealing with identifying basic layout of drawings.

IMM-B6-HO
Perform Basic Geometric Calculations
Attachment 1: **MASTER** Handout

Standards of Performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

IMM-B6-LA
Perform Basic Geometric Calculations
Attachment 2: **MASTER** Laboratory Aid

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Reading Assignments:

The following chapters are assigned to read from ***Math for Technician,*** by Edward Trunaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
8	Fundamentals of Geometry

Module Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism

IMM-B6-LW
Perform Basic Geometric Calculations
Attachment 3: MASTER Laboratory Worksheet

Practice Working Problems In The Following Areas:

a. Angles;
b. Triangle;
c. Circle;
d. Sphere;
e. Cone;
f. Solid;
g. Cylindrical;
h. Polygon; and,
i. Prism.

Name_____ Date_____

IMM-B6
Perform Basic Geometric Calculations
Self-Assessment

Solve:

1. **If a triangle has a side equal to 3 inches and another side equal to 4 inches, calculate the length of the third side.**

   _____

2. **Π Radius = _____ degrees.**

3. **Calculate the diameter of a circle. Radius equals 6 inches.**

   _____

4. **Calculate the area of a circle. Radius equals 6 inches.**

   _____

5. **Calculate the volume of a cone. The cone has a 6 inch radius and is 6 inches high.**

   _____

IMM-B6
Perform Basic Geometric Calculations
Self-Assessment Answer Key

1. $c^2 = \sqrt{a^2 + b^2}$; therefore, $c^2 = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25}$; therefore, $c = 5$

2. 360°

3. 6 x 2 = 12 inches

4. $\pi r^2 = A = 3.14\ (36) = 113.04$ sq. inches

5. $1/3\ \pi r^2\ h = (\ 1/3\ )\ (113.04)\ (6) = 223.8$ cubic inches

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacety-lene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air condition-ing systems	H-2 Maintain pneumatic control circuits	H-3 Trouble-shoot centrifugal pumps	H-4 Trouble-shoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Trouble-shoot and repair blowers	H-8 Trouble-shoot, maintain, and repair hydraulic systems	H-9 Trouble-shoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-C1

Subject: **Industrial Maintenance** **Time: 7 Hrs.**

Duty: **Interpret Engineering Drawings and Control Documents**
Task: Identify Basic Types of Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify basic types of drawings;
b. Identify mechanical blueprints;
c. Identify electrical blueprints;
d. Identify process blueprints; and,
e. Identify welding blueprints.

Instructional Materials:

MASTER Handout (IMM-C1-HO)
MASTER Self-Assessment
Drawings

References:

Blueprint Reading, TPC Publishers, Latest Edition

Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition

Reading Blueprints, Industrial Media, Inc., Latest Edition

Technology of Machine Tools, Delmar, Latest Edition

Student Preparation:

Introduction:

Drawings are an important vehicle of communication for technical personnel. Being able to work with different types of drawings is critical for a technician.

Presentation Outline:

I. Basic Types of Drawings
II. Mechanical Blueprints
III. Electrical Blueprints
IV. Process Blueprints
V. Welding Blueprints

Practical Application:

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C2) dealing with identifying basic layout of drawings.

IMM-C1-HO
Identify Basic Types of Drawings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate how to identify basic types of drawings within 85% accuracy.

Objectives:

Upon completion of this module the student will be able to:

a. Identify mechanical drawings;
b. Identify electrical drawings;
c. Identify process drawings;
d. Identify welding drawings; and,
e. HVAC drawings.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading and Sketching,*** Kirk Patrick, Latest Edition:

Chapter	Title
1	Introduction
2	Drawing Formula
21	Welding Assemblies
24	Reading Electrical and Electronics Schematic Diagrams

Module Outline:

I. Basic Types of Drawings.
   A. Mechanical
   B. Electrical
   C. Process
   D. Welding
   E. Sketch
   F. Plot plans
   G. Floor plans
   H. Contour maps
   I. Elevations
   J. Architectural
   K. Engineering Drawings

II. Mechanical

A. One view drawings
B. Two view drawings
C. Three view drawings
D. Auxiliary views
E. Isometric views
F. Orthographic views
G. Pictorial views
H. Oblique views
I. GD&T
J. Assembly
K. Hydraulic drawings
L. Pneumatic drawings
M. Machine drawings
N. Parts
O. Explored views

III. Electrical
A. Schematic diagrams
B. Single line diagrams
C. Wiring diagrams
D. Pictorial diagrams
E. Block diagrams
F. Symbols
G. Distribution
H. Plant wiring diagram

IV. Process
A. Block diagram
B. Flow diagram
C. P&ID or EFG diagram
D. Symbols
E. Piping diagrams

V. Welding
A. Symbols
B. Assembly
C. Views

VI. HVAC
A. Sheet metal
B. Ducts, duct sections
C. Diffusers
D. Triangulation

Name_____ Date_____

IMM-C1
Identify Basic Types of Drawings
Self-Assessment

Circle the letter preceding the correct answer.

1. Oblique drawings are used in _____ areas.
   A. Mechanic
   B. Electrical
   C. Welding
   D. Process

2. Isometric drawings are used in _____ areas.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

3. Single line drawings are used in _____ areas.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

4. GD&T are considered part of _____ drawings.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

5. EFD's are considered as part of _____ drawings.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

IMM-C1
Identify Basic Types of Drawings
Self-Assessment Answer Key

1. A
2. A
3. B
4. A
5. B

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-C2

Subject: **Industrial Maintenance** **Time: 6 Hrs.**

Duty: **Interpret Engineering Drawings and Control Documents**
Task: Identify Basic Layout of Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Instructional Materials:

Drawings
MASTER Handout (IMM-C2-HO)
MASTER Self-Assessment
MASTER Laboratory Worksheet (IMM-C2-LW)

References:

Blueprint Reading, TPC Publishers, Latest Edition

Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition

Reading Blueprints, Industrial Media, Inc., Latest Edition

Technology of Machine Tools, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-C1 "Identify Basic Types of Drawings"

Introduction:

Drawings are a means of communicating technical information so all technical people understand. Pictures are easier to understand than written descriptions.

Presentation Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing

Practical Application:

The student will be able to identify the basic components of the title block and other notation blocks on a blueprint.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C3) dealing with reviewing blueprint notes and dimensions.

IMM-C2-HO
Identify Basic Layout of Drawings
Attachment 1: **MASTER** Handout

Objectives:

Upon completion of this module the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading & Sketching*** ,Kirk Patrick, Latest Edition:

Chapter	Title
9	Lines For Drawings
12	Reading Two Dimensioning Drawings
15	Sectional Views
16	Auxiliary Views

Module Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing

IMM-C2-LW
Identify Basic Layout of Drawings
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Draw an isometric sketch of an object furnished by instructor.

2. Draw a three dimensional sketch of an object furnished by instructor.

3. Draw an orthographic sketch of an object furnished by instructor.

Name_____ Date_____

IMM-C2
Identify Basic Layout of Drawings
Self-Assessment

Instructor will grade these exercises.

1. Draw an isometric sketch of an object furnished by instructor.

2. Draw a three dimensional sketch of an object furnished by instructor.

3. Draw an orthographic sketch of an object furnished by instructor.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-C3

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Interpret Engineering Drawings and Control Documents
Task: Review Blueprint Notes and Dimensions

Objective(s):

Upon completion of this unit the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Instructional Materials:

MASTER Handout (IMM-C3-HO)
MASTER Self-Assessment
Mechanical Blueprints

References:

Blueprint Reading, TPC Publishers, Latest Edition

Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition

Reading Blueprints, Industrial Media, Inc., Latest Edition

Technology of Machine Tools, Delmar, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-C1 "Identify Basic Types of Drawings"
IMM-C2 "Identify Basic Layout of Drawings"

Introduction:

Mechanical drawings allow people to communicate with each other.

Presentation Outline:

I. Master Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes

Practical Application:

Student will demonstrate how to review blueprint notes and dimensions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-D1) dealing with the use of non-precision measuring tools.

IMM-C3-HO
Review Blueprint Notes and Dimensions
Attachment 1: **MASTER** Handout

Objectives:

Upon completion of this module the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading and Sketching***, Kirk Patrick, Latest Edition:

Chapter	Title
1	Introduction
17	Dimensioning
18	Tolerances

Module Outline:

I. Major Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes

Name:_____ Date:_____

IMM-C3
Review Blueprint Notes and Dimensions
Self-Assessment

Circle the letter preceding the correct answer.

1. The two types of notes shows on engineering drawings are _____.
   A. Assembly and detail
   B. Personal and business
   C. Detail and field
   D. General and specific

2. The three numbering systems used to show size and location dimensions are _____.
   A. Fractions, numbers, and letters
   B. Fractions, decimals, and metric
   C. Fractions, tolerances, and decimals
   D. Decimals, limits, and tolerance
   E. Metric, English, and decimals

3. A drawing change is begun with a form called _____.
   A. A change letter document
   B. A revision document notice
   C. An engineering revision
   D. A revision notice
   E. A document change notice

4. Which of the following does not appear in the title block?
   A. Drawing title
   B. Drawing size
   C. Revision letter
   D. Revision Descriptions
   E. None of the above

5. Half scale is correctly written as _____.
   A. 2x
   B. 2"=1
   C. 1:2
   D. 1=2

6. The first sheet of a drawing with 22 sheets is identified as _____.
   A. Sheet 1
   B. Sheet A
   C. Sheet 1 of 22

7. The abbreviation for National Taper Pipe (thread).
   A. NPT
   B. NTPT
   C. NT
   D. NTP

8. The complete finish symbol includes _____.
   A. Waviness height
   B. Waviness width
   C. Roughness width
   D. All of the above

9. A tolerance is _____.
   A. The amount of clearance shown on a drawing
   B. The amount of space between making parts
   C. The fineness of a finish
   D. The amount a part can vary from the dimension shown on the drawing

10. Document numbers _____.
   A. Is usually assigned form a drawing log
   B. Always includes the size
   C. Always includes tolerances
   D. Always includes drawing title

IMM-C3
Review Blueprint Notes and Dimensions
Self-Assessment Answer Key

1. D
2. C
3. E
4. E
5. D
6. C
7. A
8. D
9. D
10. A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-D1

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Use Measuring Tools
Task: Use Non-Precision Measuring Tools

Objective(s):

Upon completion of this module the student will be able to use the following non-precision measuring tools to 1/32" accuracy:

a. Steel Rule
b. Folding Rule
c. Steel Tape
d. Outside Calipers
e. Inside Calipers

Instructional Materials:

MASTER Handout (IMM-D1-HO)
MASTER Self-Assessment
MASTER Laboratory Aid (IMM-D1-LA)
MASTER Laboratory Worksheet (IMM-D1-LW)
Steel Rule
Folding Rule
Steel Tape
Outside Calipers
Inside Calipers

References:

Mechanics' and Millwrights' Guide, Audel Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-C3 "Review Blueprint Notes and Dimensions"

Introduction:

Measuring is an important tool for accurate construction of mechanical parts.

Presentation Outline:

I. Introduction
II. Folding Rule
III. Steel Rule
IV. Steel Tape
V. Outside and Inside Calipers

Practical Application:

1. Instructor will demonstrate proper use of non-precision measuring tools.
2. Student will demonstrate proper use of non-precision measuring tools.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-D2) dealing with the use of precision measuring tools.

IMM-D1-HO
Use Non-Precision Measuring Tools
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use steel rule;
b. Properly use folding rule;
c. Properly use steel tape;
d. Properly use outside calipers; and,
e. Properly use inside calipers.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools,* by Krar, McGraw-Hill Company, Latest Edition:

Chapter	Title
7	Measurement

Module Outline:

I. Introduction
II. Steel Rule
III. Folding Rule
IV. Steel Tape
V. Outside Calipers
VI. Inside Calipers

IMM-D1-LA
Use Non-Precision Measuring Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-D1-LW
Use Non-Precision Measuring Tools
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

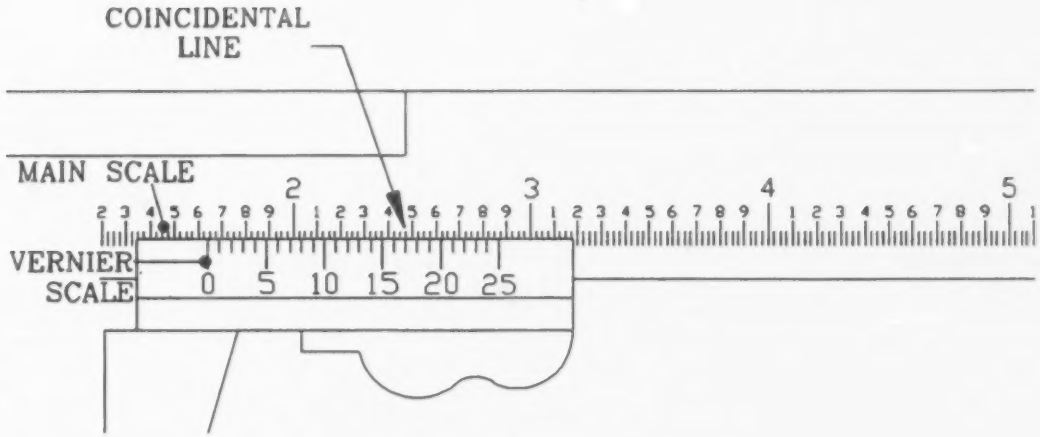
2. Instructor will grade the student's use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

Name _____ Date:_____

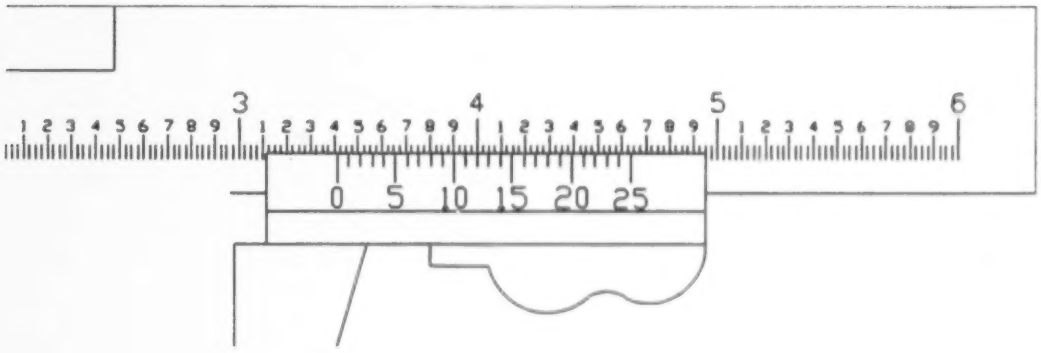
IMM-D1
Use Non-Precision Measuring Tools
Self Assessment

1. A vernier caliper gives a more precise measurement than a slide caliper because it has _____
   a. Projecting teeth
   b. A vernier scale
   c. An L-shaped frame
   d. Both inside and outside scale

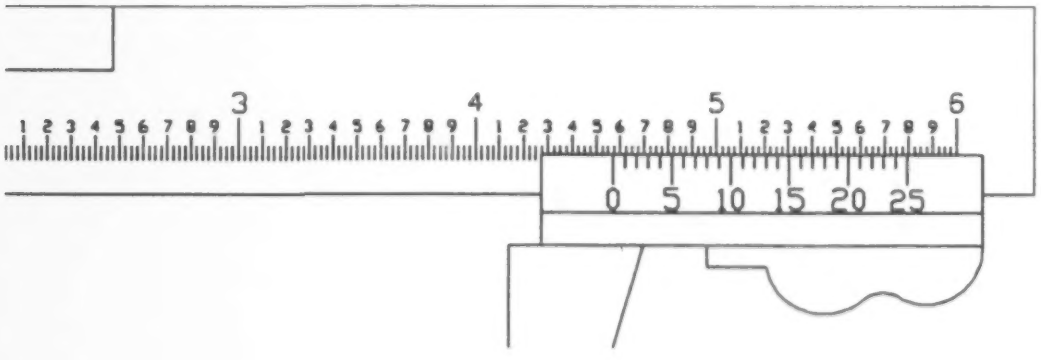
2. What is the reading on the vernier caliper below?
   a. .642
   b. 1.642
   c. 1.645
   d. 1.64



3. What is the reading on the vernier caliper below?
   a. .415
   b. 3.125
   c. 3.405
   d. 3.412

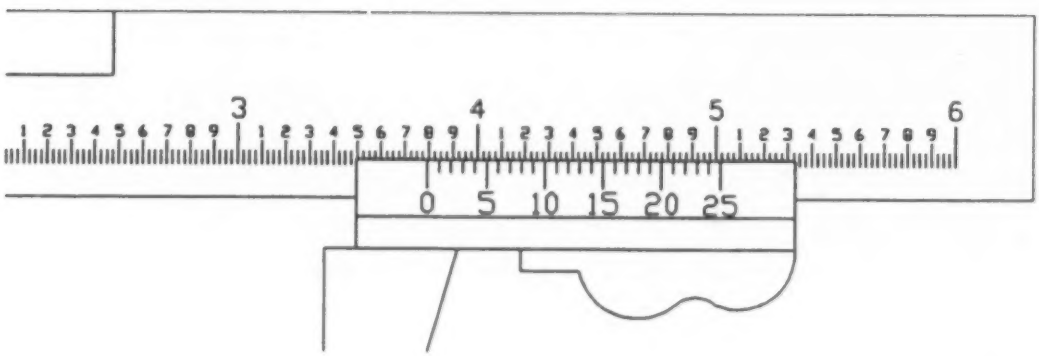


4. What is the reading on the vernier caliper below?
   a. 4.575
   b. 4.250
   c. 4.570
   d. 4.275



5. What is the reading on this vernier caliper?

a. 3.785
b. 3.800
c. 3.473
d. 3.793



IMM-D1
Use Non-Precision Measuring Tools
Self Assessment Answer Key

1. b
2. b
3. d
4. a
5. d

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-D2

Subject: **Industrial Maintenance** **Time: 10 Hrs.**

Duty: **Use Measuring Tools**
Task: Use Precision Measuring Tools

Objective(s):

Upon completion of this module the student will be able to:

a. Measure to an accuracy of 0.001;
b. Properly use vernier calipers;
c. Properly use outside micrometers;
d. Properly use depth gauges; and,
e. Properly use inside micrometers.

Instructional Materials:

Vernier Calipers
Outside Micrometer
Inside Micrometer
MASTER Handout (IMM-D2-HO)
MASTER Self-Assessment
MASTER Laboratory Aid (IMM-D2-LA)
MASTER Laboratory Worksheet (IMM-D2-LW)

References:

Mechanics' and Millwrights' Guide by Carl Nelson, Audel Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-D1 "Use Non-Precision Measuring Tools"

Introduction:

Precision tools are often used to measure angular or linear distances when accuracy is very important in order to make parts for smooth operation.

Presentation Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge

Practical Application:

Student will demonstrate proper use of precision measuring tools. The accuracy will be held to plus or minus 0.001.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-E1) dealing with identification and use of maintenance technician's hand tools.

IMM-D2-HO
Use Precision Measuring Tools
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use vernier calipers;
b. Properly use outside and inside micrometers;
c. Properly use depth gauges; and,
d. Properly use dial indicators.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools,* by Krar, McGraw-Hill, Latest Edition:

Chapter	Title
9	Micrometer
10	Vernier Calipers
11	Inside, Depth and Height Measuring Instruments

Module Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge

IMM-D2-LA
Use Precision Measuring Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-D2-LW
Use Precision Measuring Tools
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

2. Student will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

3. Instructor will grade student's ability to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gauges
   e. Dial Indicators

Name:_____ Date:_____

IMM-D2
Use Precision Measuring Tools
Self-Assessment

1. The outside and inside caliper must be read or set with a _____.
   A. Height gage
   B. Solid square
   C. Gage block
   D. Steel rule

2. The outside caliper legs:
   A. Curve outward
   B. Curve inward
   C. Have one point and one curved
   D. Have two points

3. The inside caliper legs:
   A. Curve outward
   B. Curve inward
   C. Have one point one curved
   D. Have two points

4. When checking the measurement of an outside caliper have one leg:
   A. Hooked on the end of a steel rule
   B. On the 1" mark of a steel rule
   C. On the 32nd scale of a steel rule
   D. And the steel rule on a flat surface

5. When checking the measurement of an inside caliper, have one leg of the caliper:
   A. Hooked on the end of a steel rule
   B. On the 1" mark of a steel rule
   C. On the 32nd scale of a steel rule
   D. And the steel rule on a flat surface

6. How many numbered lines are there on the sleeve of an outside micrometer caliper?
   A. 40
   B. 30
   C. 20
   D. 10

7. What is the value or each numbered line on the sleeve?
   A. .010
   B. .025
   C. .100
   D. .0001

8. What is the total number of lines on the sleeve of an outside micrometer caliper?
   A. 25
   B. 30
   C. 35
   D. 40

9. What is the value of each line on the sleeve?
   A. .010
   B. .025
   C. .100
   D. .0001

10. How many lines are there on the thimble?
   A. 25
   B. 50
   C. 100
   D. 1000

11. What is the value of each line on the thimble?
   A. .100
   B. .050
   C. .025
   D. .001

12. How many threads per inch are there on the spindle of a micrometer?
   A. 25
   B .40
   C 100
   D 1000

13. One turn of the thimble advances the spindle of a micrometer:
   A. .001
   B. .010
   C. .025
   D. .100

14. What should be used to check a 2" micrometer for accuracy?
    A. Spindle to anvil
    B. 1" standard
    C. ½" standard
    D. 1" hot roll steel

15. After the telescoping gauge is set to size, it must be read with an:
    A. Outside caliper
    B. Inside caliper
    C. Outside micrometer
    D. Inside micrometer

16. Some vernier caliper and dial calipers will measure:
    A. Depth
    B. Outside diameters
    C. Inside diameters
    D. All of the above

IMM-D2
Use Precision Measuring Tools
Self-Assessment Answer Key

1. D
2. B
3. A
4. A
5. D
6. D
7. C
8. D
9. B
10. A
11. D
12. B
13. C
14. B
15. C
16. D

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks													
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout								
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations								
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions											
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools												
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools												
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press								
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering											
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems					
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches										
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together											

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INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Tasks →

Duties														
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-E1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-E1

Subject: Industrial Maintenance **Time: 6 Hrs.**

Duty: Use Hand Tools
Task: Identify and Use Maintenance Technician's Hand Tools

Objective(s):

Upon completion of this module the student will be able to:

a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Instructional Materials:

MASTER Handout (IMM-E1-HO)
MASTER Laboratory Aid (IMM-E1-LA)
MASTER Laboratory Worksheet (IMM-E1-LW)
MASTER Self-Assessment
Pliers
Hammers
Punches
Wrenches
Chisels
Bars
Screwdrivers

References:

Mechanics' and Millwrights' Guide by Carl Nelson, Audel Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-D2 "Use Precision Measuring Tools"

Introduction:

Hand tools serve as an extension of a maintenance mechanic's mind. These tools allow the mechanic to gain torque and leverage.

Presentation Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers

Practical Application:

1. Instructor will demonstrate how to safely and correctly use hand tools.
2. Student will demonstrate how to safely and correctly use hand tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-E2) identifying and using hand held power tools.

IMM-E1-HO
Identify and Use Maintenance Technician's Hand Tools
Attachment 1: MASTER Handout

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will demonstrate the:

a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Module Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers

IMM-E1-LA
Identify and Use Maintenance Technician's Hand Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-E1-LW
Identify and Use Maintenance Technician's Hand Tools
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear Plugs
   Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

Name:_____ Date:_____

IMM-E1
Identify and Use Maintenance Technician's Hand Tools
Self-Assessment

1. The size of any wrench is determined by the _____.
   A. Overall length
   B. Opening between its jaws
   C. Clearance on the nut and bolt
   D. Diameter of the shank

2. What type of screwdriver has square shanks?
2. A. Phillips
   B. Cabinet
   C. Wide tip
   D. Heavy duty

3. A hammer that has a rubber face is called a _____ hammer.
   A. Mallet
   B. Claw
   C. Ball peen
   D. Sledge

4. A plier that has a long bill is called a _____ plier.
   A. Combination
   B. Long nose
   C. Needle nose
   D. Reversible pliers

5. This tool is used to remove nails.
   A. Nail claw
   B. Pry bar
   C. Nipping tool
   D. Wrecking bar

IMM-E1
Identify and Use Maintenance Technician's Hand Tools
Self-Assessment Answer Key

1. B
2. D
3. A
4. B
5. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-E2

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Use Hand Tools
Task: Identify and Use Hand Held Power Tools

Objective(s):

Upon completion of this module the student will be able to:

a. Identify typical use and application of a hand drill and a hand power screwdriver;
b. Identify typical use and application of a reciprocating saw;
c. Identify typical use and application of a circular saw;
d. Identify typical use and application of hand held high-speed pneumatic tools;
e. Identify typical use and application of a hand held electric or pneumatic side grinder;
f. Identify typical use and application of electric or pneumatic impact tools; and,
g. Demonstrate safe operation of hand held power tools to established performance measures.

Instructional Materials:

MASTER Handout (IMM-E2-HO)
MASTER Laboratory Aid (IMM-E2-LA)
MASTER Laboratory Worksheet (IMM-E2-LW)
MASTER Self-Assessment
Lab Equipment:
- Hand drill and power screwdriver
  - Assorted drill bits
  - Assorted screwdriver bits
  - Chuck key
  - Material suitable for drilling practice and demonstration
- Reciprocating saw
  - Assorted blades
  - Material suitable for practice and demonstration
  - Allen wrench
- Circular saw

Assorted blades
Material suitable for practice and demonstration
Wrench appropriate to install blade
Hand held high-speed pneumatic pencil/peewee grinder
Assorted cut off, grinding and polishing wheels
Assorted carbide burrs
Hand held electric or pneumatic side grinder
Assorted grit grinding wheels
Electric/pneumatic impact tools
Material suitable for practice and demonstration
Impact socked set
Impact chisel

References:

Portable Power Tools by Leo P. McDonnell, Latest Edition

The Complete Book of Portable Power Tool Techniques by R. J. DeCristoforo, Latest Edition

The TAB Handbook of Hand & Power Tools by Rudolf F. Graf and George J. Whalen, Latest Edition

Power Tool Safety: A Skill You Need On the Job, (video recording), Towson, M.D., Black & Decker, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-E1 "Identify and Use Maintenance Technician's Hand Tools"

Introduction:

Powered hand tools are used to supply higher torque and at a higher speed of movement than hand tools. This reduces the manual labor and allows one to accomplish more in the same amount of time.

Presentation Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation

D. Application

II. Identify Typical Use and Application for a Reciprocating Saw
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application

III. Identify Typical Use and Application of a Circular Saw
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
   A. Safety
   B. Selecting proper tool bits
   C. Operation
   D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
   A. Safety
   B. Selecting proper grit wheel
   C. Operation
   D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures

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Practical Application:

Instructor will demonstrate proper and safe use of portable power tools. Student will observe instructor and demonstrate proper and safe use of portable power tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F1) dealing with the use and care of milling machines.

IMM-E2-HO
Identify and Use Hand Held Power Tools
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Identify typical use and application of a hand drill and a hand power screwdriver;
b. Identify typical use and application of a reciprocating saw;
c. Identify typical use and application of a circular saw;
d. Identify typical use and application of hand held high-speed pneumatic tools;
e. Identify typical use and application of a hand held electric or pneumatic side grinder;
f. Identify typical use and application of electric or pneumatic impact tools; and,
g. Demonstrate safe operation of hand held power tools to established performance measures.

Module Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation
   D. Application
II. Identify Typical Use and Application for a Reciprocating Saw
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application
III. Identify Typical Use and Application of a Circular Saw
   A. Safety

B. Selecting proper blade
C. Operation
D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
A. Safety
B. Selecting proper tool bits
C. Operation
D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
A. Safety
B. Selecting proper grit wheel
C. Operation
D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
A. Safety
B. Selecting proper blade
C. Operation
D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures

IMM-E2-LA
Identify and Use Hand Held Power Tools
Attachment 2: MASTER Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-E2-LW
Identify and Use Hand Held Power Tools
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Safety glasses
   Leather gloves
   Face shields
   Ground fault protector
   Safety curtains lab equipment

3. Lab Equipment:
   - Hand drill and power screwdriver
     - Assorted drill bits
     - Assorted screwdriver bits
     - Chuck key
     - Material suitable for practice and demonstration
   - Reciprocating saw.
     - Assorted blades
     - Material suitable for practice and demonstration
     - Allen wrench
   - Circular saw.
     - Assorted blades
     - Material suitable for practice and demonstration
     - Wrench appropriate to install blade
   - Hand held electric-speed pneumatic pencil/pewee grinder
     - Assorted cut off, grinding and polishing wheels
     - Assorted carbide burrs
   - Hand held electric or pneumatic side grinder.
     - Assorted grit grinding wheels
   - Electric/pneumatic impact tools.
     - Material suitable for practice and demonstration
     - Impact socket set
     - Impact chisel

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercise using each tool in No. 3 above.

Name _____ Date:_____

IMM-E2
Identify and Use Hand Held Power Tools
Self-Assessment

The student will be evaluated on the following performances and standards:

1. Use a hand drill and a power screwdriver for the task assigned.
   A. Select proper bits
   B. Safety install bit and drill hole in designated stock in such a manner as not to damage equipment or endanger personnel.
   C. Safety install bit and drive a screw using a power screw-driver in such a manner as not to damage equipment or endanger personnel.

2. Use a reciprocating saw to cut material to within 1/16" of designated dimension.
   A. Select proper blade
   B. Safely install the correct blade and cut a board to with in 1/16" of designated dimension

3. Use a circular saw to cut a board to within 1/16: of designated dimension.
   A. Select proper blade
   B. Safely install the correct blade and cut a board to with in 1/16" of designated dimension

4. Use hand held high-speed pneumatic tools.
   A. Select proper tool bits
   B. Install the correct bit and operate the equipment tool in such a manner as not to damage equipment or endanger personnel.

5. Use a hand held electric or pneumatic side grinder.
   A. Setup curtains for grinding
   B. Select proper grit wheel
   C. Install the correct wheel and operate the equipment in such a manner as not to damage equipment or endanger personnel.

6. Use electric or pneumatic impact tools.
   A. Select proper socket or chisel for the task assigned
   B. Install the tool and operate the equipment in such a manner as not to damage equipment or endanger personnel.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F1

Subject: Industrial Maintenance **Time: 40 Hrs.**

Duty: Operate Machine Tools
Task: Use and Care of Milling Machines

Objective(s):

Upon completion of this module the student will be able to demonstrate proper use of milling machine to include:

a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Instructional Materials:

MASTER Handout (IMM-F1-HO)
MASTER Laboratory Aid (IMM-F1-LA)
MASTER Laboratory Worksheet (IMM-F1-LW)
MASTER Self-Assessment
Milling Machine (Horizontal and Vertical)

References:

Major Process Equipment Maintenance and Repair by Fred Geitner, Gulf Publishing Company, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-E2 "Identify and Use Hand Held Power Tools"

Introduction:

Milling machines are used for many machining operation. These include cutting, planning, and shaping of metals. Many parts must be made and milling machines.

Presentation Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Depth of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling
IX. Cam, Worm Milling
X. Vertical Milling Machine

Practical Application:

1. Instructor will demonstrate how to properly use milling machines.
2. Student will demonstrate how to properly use milling machines.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F2) dealing with the use and care of horizontal and vertical band saws.

IMM-F1-HO
Use and Care of Milling Machines
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall:

1. Identify the two major factors in working safely;
2. List four steps you can take prior to performing work that will insure a safe outcome;
3. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
4. Select specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to demonstrate proper use of milling machines to include:

a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Reading Assignments:

The following chapters are assigned to read from ***Technology of Machine Tools,*** by Krar, McGraw-Hill Pub., Latest Edition:

Chapter	Title
12	Milling Machine

Module Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Dept of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling

IX. Cam, Worm Milling
X. Vertical Milling Machine

IMM-F1-LA
Use and Care of Milling Machines
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

IMM-F1-LW
Use and Care of Milling Machines
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate:
   - A. Milling Machine and Accessories
   - B. Milling Cutters
   - C. Speeds, Feeds and Dept of Cut
   - D. Setups
   - E. Operations (Horizontal)
   - F. Indexing
   - G. Gear Cutting
   - H. Helical Milling
   - I. Cam, Worm Milling
   - J. Vertical Milling Machine

2. Student will be graded on proper operation and part fabrication by milling machine.

Name:_____ Date:_____

IMM-F1
Use and Care of Milling Machine
Self-Assessment

1. List three variety of surfaces that a milling machine can mill.
   _____
   _____
   _____

2. Briefly describe the function of a milling machine.
   _____
   _____
   _____

3. Why should the knee clamps and saddle clamps be tightened when milling?
   _____
   _____
   _____

4. List three directions the table can be adjusted on a column and knee milling machine.
   _____
   _____
   _____

5. The two basic types of milling machines are the _____ and the _____.

6. Compare the horizontal milling machine to the vertical milling machine.
   _____
   _____
   _____

7. The crossfeed handwheel is used to _____
   _____.

8. The table traverse handwheel is used to _____
   _____.

9. What is the purpose of a backlash eliminator?_____
   _____.

10. **The arbor support is used to** _____
_____.

IMM-F1
Use and Care of Milling Machine
Self-Assessment Answer Key

1. Horizontal, vertical and angular.

2. The milling machine cuts metal with a multi tooth cutting tool.

3. Lock knee to column, reduce table vibration.

4. Horizontal, traverse and vertical.

5. Column and knee, bed

6. The horizontal types have the milling cutter mounted on a horizontal arbor, whereas, the vertical types have a spindle in a vertical position.

7. Move the table either away from or toward the column.

8. Manual table feed.

9. The work piece must be clamped securely in order to compensate for wear or backlash.

10 Milling cutter(s) are mounted on the arbor.

IMM-F2

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F2

Subject: Industrial Maintenance **Time: 16 Hrs.**

Duty: Operate Machine Tools
Task: Use and Care of Horizontal and Vertical Band Saws

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the component parts of horizontal and vertical band saw;
b. Describe the purpose and operation of the components of a horizontal and vertical band saw;
c. Demonstrate how to remove, install and adjust the blade of a horizontal and vertical band saw;
d. Demonstrate how to adjust the blade guards and guides of a horizontal and vertical band saw;
e. Identify the safety concerns associated with band saw operation;
f. Setup and operate a band saw to a designated tolerance without endangering personnel or equipment; and,
g. Weld saw blade (if saw has a welder attachment).

Instructional Materials:

MASTER Handout (IMM-F2-HO)
MASTER Laboratory Aid (IMM-F2-LA)
MASTER Laboratory Worksheet (IMM-F2-LW)
MASTER Self-Assessment
Horizontal band saw
Vertical band saw
Replacement blades for metal and wood
Safety glasses
Heavy gloves
Stock suitable for practice
Hand tools as needed for adjustments
Ruler

References:

Machine Shop Operations and Setup, Lascoe, Nelson and Porter, American Technical Society, Latest Edition

Machinist Library, Basic Machine Shop, Miller and Brueckman, Audel, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-F1 "Use and Care of Milling Machines"

Introduction:

One of the most basic types of machine shop equipment is the category of power saws. The machinist will need to be very familiar with the setup and operation of all the types of saws commonly found in the machine shop. Power saws fall into classifications: cutoff saws and the contour bandsaw. This lesson discusses the topics which pertain to the blade selection, setting of blade surface feet per minute and safe operation of these saws.

Presentation Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   - A. Blade
   - B. Blade guard
   - C. Coolant system (if used)
   - D. Work clamp (if used)
   - E. Blade tensioning device
   - F. On/off and feed controls

II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw
   - A. Blade
     1. Different types
   - B. Blade guard
     1. Adjustment techniques
   - C. Coolant system (if used)
     1. Types of coolant
     2. When coolant is needed
     3. Adjusting flow control
   - D. Work clamp (if used)
     1. Purpose
     2. How to adjust

E. Blade tensioning device
    1. How to tighten and loosen
    2. Recognizing proper tension
F. On/off and feed controls
    1. On-off and remote power switches
    2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw
    A. How to loosen
    B. Correct operating position
    C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation
    A. Airborne derbies
    B. Exposed cutting surface
    C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades

Practical Application:

1. Practice removing, installing and adjusting the blade tension of a horizontal and vertical band saw.
2. Practice adjusting the blade guards and guides of a horizontal and vertical band saw.
    A. Loosen
    B. Correct operating position
    C. Tighten
3. Identify the safety concerns associated with band saw operation.
    A. Airborne debris
    B. Exposed cutting surface
    C. Sharp edges
4. Practice setup and operating a band saw to a designated tolerance without endangering personnel or equipment.
5. Demonstrate how to use weld saw blades.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F3) dealing with the use and care of pedestal grinders.

IMM-F2-HO
Use and Care of Horizontal and Vertical Band Saws
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of horizontal band saw; and,
b. Demonstrate proper use and care of vertical band saw.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, by Krar, McGraw-Hill Publishing, Latest Edition:

Unit	Title
35	Types of Metal Saws
36	Bandsaw Parts and Accessories
37	Bandsaw Operations

Module Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   A. Blade
   B. Blade guard
   C. Coolant system (if used)

D. Work clamp (if used)
E. Blade tensioning device
F. On/off and feed controls

II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw
   A. Blade
      1. Different types
   B. Blade guard
      1. Adjustment techniques
   C. Coolant system (if used)
      1. Types of coolant
      2. When coolant is needed
      3. Adjusting flow control
   D. Work clamp (if used)
      1. Purpose
      2. How to adjust
   E. Blade tensioning device
      1. How to tighten and loosen
      2. Recognizing proper tension
   F. On/off and feed controls
      1. On-off and remote power switches
      2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw
   A. How to loosen
   B. Correct operating position
   C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation
   A. Airborne derbies
   B. Exposed cutting surface
   C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades

IMM-F2-LA
Use and Care of Horizontal and Vertical Band Saws
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.

IMM-F2-LW
Use and Care of Horizontal and Vertical Band Saws
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

2. Student will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

3. Instructor will grade student's performance.

Name:_____ Date:_____

IMM-F2
Use and Care of Horizontal and Vertical Band Saws
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following is not normally classified as a cutoff saw?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive

2. Which type of saw is most productive when preparing bar stock for machining operations?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive saw

3. Which type of saw is most useful for sawing parts having unusual angles and radii?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive saw

4. Which of the following refers to the number of teeth per inch for a saw blade?
   A. Set
   B. Gage
   C. TPI
   D. Pitch

5. Using your answer to question 4, which is best for general purpose sawing?
   A. 4
   B. 6
   C. 10
   D. 14

6. Which type of sawing can be done using a blade with no teeth?
   A. Precision
   B. Soft materials
   C. Abrasive
   D. Friction

7. What happens if too fast a blade speed is used?
   A. You finish the job sooner
   B. You burn up the saw blade
   C. You increase production
   D. You injure yourself

8. What do you do if the saw blade dulls or breaks before the cut is completed?
   A. Stop the saw
   B. Replace the blade with a new one
   C. Re-start the cut in a new location
   D. All of the above

9. How is the blade speed adjusted on a contour bandsaw?
   A. Change the belts
   B. Change the blade
   C. Adjust the handwheel
   D. Adjust the blade supports and guides

10. Which of the following is *not* a requirement of a sawing job?
   A. Color
   B. Safety
   C. Tool life
   D. Accuracy

IMM-F2
Use and Care of Horizontal and Vertical Band Saws
Self-Assessment Answer Key

1. B
2. A
3. A
4. D
5. C
6. D
7. B
8. D
9. A and C
10. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F3

Subject: Industrial Maintenance **Time: 3 Hrs.**

Duty: Operate Machine Tools
Task: Use and Care of Pedestal Grinder

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Instructional Materials:

MASTER Handout (IMM-F3-HO)
MASTER Laboratory Aid (IMM-F3-LA)
MASTER Laboratory Worksheet (IMM-F3-LW)
MASTER Self-Assessment
Pedestal grinder
Assorted wheels
Stock suitable for practice
Face shield
Safety glasses
Wheel dresser
Hand tools as required to maintain the grinder

References:

Machine Shop Operations and Setup, Lascoe, Nelson and Porter, American Technical Society, Latest Edition

Machinist Library, Basic Machine Shop, Miller and Brueckman, Audel, Latest Edition

Grinding Technology, Stephen Krar and J. Oswald, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-F2 "Use and Care of Horizontal and Vertical Band Saws"

Introduction:

Pedestal grinding are made for less rugged use than the surface grinder. The grinders are not as precise as the surface grinder also.

Presentation Outline:

I. Identify the Component Parts of a Pedestal Grinder
   - A. Pedestal
   - B. Motor
   - C. Spindle
   - D. Toolrest (guard)
   - E. Grinding wheel and vibration pads
   - F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
   - A. Different types of dressing tools
   - B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
   - A. Fast feed-rapid metal abrasion with course finish
   - B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
   - A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
   - A. Blocking spindle rotation
   - B. Removing guards
   - C. Removing mounting nut and washers
   - D. Sounding a wheel for flaws

E. Mounting the wheel, vibration pads, washer and nut
F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
A. Flying grinding dust
B. Disintegrating wheel
C. Wheel may throw small parts
E. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)

Practical Application:

Practice identifying the component parts of a pedestal grinder:
Pedestal;
Motor;
Spindle;
Toolrest (guard);
Grinding wheel and vibration pads; and,
Coolant supply.

Practice dressing a grinding wheel:
Different types of dressing tools; and,
Distinction between a properly and an improperly dressed wheel.

Practice feeding stock at different speeds and examine the resulting surface quality:
Fast feed-rapid metal abrasion with course finish; and,
Slow feed-slower metal removal and finer finish.

Practice adjusting the tool rest of a pedestal grinder:
Distance from wheel; and,
Position in relation to horizontal axis of the spindle.

Practice removing, testing and installing a grinding wheel on a pedestal grinder:
Blocking spindle rotation;
Removing guards;
Removing mounting nut and washers;
Sounding a wheel for flaws;
Mounting the wheel, vibration pads, washer and nut; and,
Replacing guards.

Identify the safety concerns relative to operation of a pedestal grinder:
Flying grinding dust;
Disintegrating wheel;

Wheel may throw small parts; and,
Danger of hand or fingers being pulled into wheel if small parts are improperly secured.

Set up and operate a pedestal grinder without endangering personnel or equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F4) dealing with the use and care of surface grinders.

IMM-F3-HO
Use and Care of Pedestal Grinder
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Reading Assignments:

The following chapters are assigned to read from ***Technology of Machine Tools***, by Krar, McGraw-Hill Publications, Latest Edition

Unit	**Topic**
85	Cylinder Grinder

Module Outline:

I. Identify the Component Parts of a Pedestal Grinder
   A. Pedestal
   B. Motor
   C. Spindle
   D. Toolrest (guard)

E. Grinding wheel and vibration pads
F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
A. Different types of dressing tools
B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
A. Fast feed-rapid metal abrasion with course finish
B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
A. Blocking spindle rotation
B. Removing guards
C. Removing mounting nut and washers
D. Sounding a wheel for flaws
E. Mounting the wheel, vibration pads, washer and nut
F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
A. Flying grinding dust
B. Disintegrating wheel
C. Wheel may throw small parts
D. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)

IMM-F3-LA
Use and Care of Pedestal Grinder
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

IMM-F3-LW
Use and Care of Pedestal Grinder
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

2. Student will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

3. Instructor will grade student's performance on:
   A. Demonstrating proper use and care of pedestal grinder; and,
   B. Set up and operating a pedestal grinder without endangering personnel or equipment.

Name:_____ Date:_____

IMM-F3
Use and Care of Pedestal Grinder
Self-Assessment

1. What are three reasons for grinding?

2. Briefly describe grades of wheels used for a pedestal grinder.

3. Grinding wheel faces are known by different _____.

4. When ordering grinding wheels, what information is needed?

5. The standard marking system for wheels includes _____

6. Describe the tool rest adjustment for a pedestal grinder.

7. Describe the correct method of mounting a grinding wheel on a pedestal grinder.

8. What is dressing a grinding wheel?

IMM-F3
Use and Care of Pedestal Grinder
Self-Assessment Answer Key

1. Sharpen cutting edges on tools, make surfaces smoother, and cut metal to desired shape.
2. Grades range from soft to hard.
3. Letters
4. Speed of machine, Diameter of hole, Shape of wheel, Type of wheel face, Diameter of wheel, and Thickness of wheel.
5. Abrasive type, grain size, bond type, grade and structure.
6. The tool rest should be set as close as possible to the wheel without touching the wheel.
7. Precaution! Since grinding wheels are abrasive, the wheels are easy to break, be careful. Never force the wheel onto a shaft! Place washers slightly larger than diameter of the flanges should be placed between the sides of the wheels and flanges. Tighten nut only enough to hold wheel firmly. Start grinder and true wheel with a grinding wheel dresser.
8. Sharpening a wheel.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F4

Subject: Industrial Maintenance **Time: 3 Hrs.**

Duty: Operate Machine Tools
Task: Use and Care of Surface Grinder

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Instructional Materials:

MASTER Handout (IMM-F4-HO)
MASTER Laboratory Aid (IMM-F4-LA)
MASTER Laboratory Worksheet (IMM-F4-LW)
MASTER Self-Assessment
Surface grinder
Instrumentation material
2" bar stock for practice
Safety glasses/side shields
Face shields
Micrometer or dial caliper
Basic hand tools for wheel replacement
Wheel dresser

References:

Machine Shop Operations and Setup, Lascoe, Nelson and Porter, American Technical Society, Latest Edition

Machinist Library, Basic Machine Shop, Miller and Brueckman, Audel, Latest Edition

Grinding Technology, Stephen Krar and J. Oswald, Delmar Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-F3 "Use and Care of Pedestal Grinder"

Introduction:

Grinders enable a maintenance mechanic to turn a surface or edge of materials from a rough surface into a smooth surface.

Presentation Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat
II. Identify the Component Parts of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system
III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system
IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
   A. Clamping using a magnetic base
   B. Clamping using dogs

V. Describe the Relationship Between Speed, Feed and Surface Quality
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed
VI. Identify Safety Concerns Relative to Using a Surface Grinder
   A. Work coming loose
   B. Flying derbies
   C. Wheel disintegrating
   D. Moving parts
VII. Setup and Operate a Surface Grinder to a Tolerance of .002" Without Endangering Personnel or Equipment

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Practical Application:

I. Practice the operation of the power, feed and speed controls of a surface grinder
   A. Control levers
   B. Wheel
   C. Coolant system
II. Practice mounting a part using a magnetic base and using dog clamps
   A. Clamping using a magnetic base
   B. Clamping using dogs
III. Practice operating the grinder at different speed and feed and compare the surface qualities
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed
IV. Point out safety concerns relative to using a surface grinder
   A. Work coming loose
   B. Flying debris
   C. Wheel disintegrating
   D. Moving parts
V. Practice setup and operating a surface grinder to a tolerance of .002 without endangering personnel or equipment

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Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F5) dealing with operation of lathes.

IMM-F4-HO
Use and Care of Surface Grinder
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools* by Krar, McGraw-Hill Publisher, Latest Edition:

Unit	Title
82	Types of Abrasives
83	Surface Grinders and Accessories
84	Surface Grinding Operations

Module Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat

II. Identify the Component Parts of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
   A. Clamping using a magnetic base
   B. Clamping using dogs

V. Describe the Relationship Between Speed , Feed and Surface Quality.
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

VI. Identify Safety Concerns Relative to Using a Surface Grinder
   A. Work coming loose
   B. Flying debris
   C. Wheel disintegrating
   D. Moving parts

VII. Setup and Operate a Surface Grinder to a Tolerance of .002" Without Endangering Personnel or Equipment

IMM-F4-LA
Use and Care of Surface Grinder
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-F4-LW
Use and Care of Surface Grinder
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

2. Student will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

3. Instructor will grade student's performance on setup and operating a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Name_____ Date:_____

IMM-F4
Use and Care of Surface Grinder
Self-Assessment

1. The _____ is located in the wheel head and provides for the mounting of the grinding wheel.
   a. Saddle or cross slide
   b. Table
   c. Base
   d. Spindle

2. The surface grinder table has accessories bolted on it by means of a:
   a. Dove tail
   b. Flat way
   c. V-ways
   d. T-slot

3. The spindle of a surface grinder has a:
   a. Key-seat
   b. Straight shank
   c. Taper
   d. V-grove

4. The grinding wheel is mounted on the:
   a. Adapter
   b. Spindle
   c. Column
   d. Wheelhead hand wheel

5. To make a hard grinding wheel act softer:
   a. Decrease the work feed
   b. Decrease the wheel speed
   c. Increase the wheel speed
   d. Increase the coolant flow

6. The most common toolroom surface grinder has:
   a. Horizontal spindle and a reciprocating table
   b. Horizontal spindle and a rotary table
   c. Vertical spindle and a reciprocating table
   d. Vertical spindle and a rotary table

7. An excessive amount of imbalance of the grinding wheel will damage the:
   a. Work surface
   b. Grinding wheel
   c. Table
   d. Spindle bearings

8. Before balancing a grinding wheel it must be:
   a. Sprayed
   b. Dressed
   c. Trued
   d. Reversed

9. The wheel is balanced by counterbalances located in the:
   a. Flange
   b. Spindle
   c. Grinding wheel
   d. Motor

10. To rough dress the wheel take .001-.002 in. at a:
   a. High feed rate
   b. Higher speed rate of the wheel
   c. Slow feed rate
   d. 450 angle

11. Most ferrous metal is held on a surface grinder by:
   a. Bolting to the table
   b. A vise
   c. A magnetic chuck
   d. V-blocks

12. Grinding fluids are used on surface grinders to reduce heat, remove swarf, control dust, and
   a. Lubricate the work
   b. Easy removal of work
   c. Lubricate the chuck
   d. Cool the table bearings

13. Before grinding a flat workpiece be sure to:
   a. Machine to finished size
   b. Remove all burrs
   c. Dip in oil to help lubrication
   d. Heat treat

14. When blocking short workpiece, to be held securely, with parallels or steel pieces they must be _____ than the finished workpiece.
    a. Harder
    b. Thinner
    c. Thicker
    d. Clearer

15. The grinding wheel should clear the end of the workpiece when setting the trip dogs by approximately:
    a. 1"
    b. 3"
    c. 5"
    d. 7"

16. After the wheel just sparks the workpiece, in set-up, raise the wheel .005" and move the table slowly by hand over the entire surface to locate the:
    a. Start position
    b. End position
    c. High point
    d. Low point

17. When making a roughing cut, on the surface grinder, the depth should be _____ of an inch.
    a. .00005-.0001
    b. .0005-.001
    c. .001-.003
    d. .005-.010

18. When a work holding device is not used to grind an angle an angular cut may be made by:
    a. Swiveling the table
    b. Tilting the table
    c. Dressing the wheel to the desired angle
    d. Tilting the head

19. Some surface grinders may not be used for crush-forming because:
    a. The table is too small
    b. The wheel is too soft
    c. The spindle bearings may be damaged
    d. The table will not tilt

20. To cut-off a large workpiece on a surface grinder, the table is:
    a. Reciprocated
    b. Stationary
    c. Turned to 45 degrees
    d. Raised

IMM-F4
Use and Care of Surface Grinder
Self-Assessment Answer Key

1. D
2. D
3. C
4. A
5. B
6. A
7. D
8. C
9. A
10. A
11. C
12. A
13. B
14. B
15. A
16. C
17. C
18. C
19. C
20. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F5

Subject: Industrial Maintenance **Time: 68 Hrs.**

Duty: Operate Machine Tools
Task: Operate Lathes

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Instructional Materials:

Tool grinder
Instructional material
Hand tools
Assortment of outside micrometers up to 3"
Lab standards, MASTER Laboratory Aid (IMM-F5-LA)
Depth gage
Telescoping gage
Dial calipers
Tool stock
Handout reading assignments in textbook, objectives, and outlines
MASTER Handout (IMM-F5-HO)
Side shield and face shield
2" Stock for practice and evaluation
Engine lathe
Technology of Machine Tools, Krar, McGraw-Hill Publishers, Latest Edition, Chapters 45-52, and 53
MASTER Video Tape (IMM-F5-VT1)

MASTER Laboratory worksheets (IMM-F5-LW1 and IMM-F5-LW2)

References:

Modern General Shop, Brown, W. C., et al., South Holland, IL, Goodheart-Willcox, Latest Edition

General Metals, Feirer, J. L., New York, McGraw-Hill, Latest Edition

Machine Tool Practices, Kibbe, R. A., et al., New York, John Wiley & Sons, Latest Edition

Machine Tool Operations: An Introduction, Matt, S. R., Belmont, CA, Wadsworth, Latest Edition

The following video tapes available from Bergwall Productions in series 501(Lathe), Latest Edition:

1. "Basic Parts," #501.01X-1 VHS
2. "Setting Up Work," #501.02X-2 VHS
3. "Accessories," #501.03X-1 VHS
4. "Work Operations On 3 And 4 Jaw Chucks," #501.04X-1 VHS
5. "Three Ways To Taper," #501.04X-1 VHS
6. "Cutting A Thread," #501.06X-1 VHS

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6	"Practice Safety"
IMM-B1 through IMM-B6	"Apply Mathematical Concepts"
IMM-C1 through IMM-C3	"Interpret Engineering Drawings and Control Documents"
IMM-D-1 through IMM-D2	"Use Measuring Tools"
IMM-E1 through IMM-E2	"Use Hand Tools"
IMM-F1	"Use and Care of Milling Machines"
IMM-F2	"Use and Care of Horizontal and Vertical Band Saws"
IMM-F3	"Use and Care of Pedestal Grinder"
IMM-F4	"Use and Care of Surface Grinder"

Introduction:

The lathe is a powered machine capable of producing many cylindrical devices used in many everyday and industrial applications. Usually the raw product is a piece of rolled solid stock. A maintenance mechanic may need to fabricate a part from a raw product or repair an existing part. The lathe is one of the most common powered tools found in

a machine shop or maintenance shop in an industrial plant. If a part is cylindrical, the lathe was probably used to produced the part. Using the lathe to some degree of expertise is important to a maintenance mechanic.

Presentation Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile

II. Identify and Discuss Component Parts of an Engine Lathe
   A. Control panel
   B. Bed & ways
   C. Head stock
   D. Gear box
   E. Carriage
   F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
   A. Centers
   B. Chucks
   C. Faceplates
   D. Mandrels
   E. Steady and follower rest
   F. Lathe dogs
   G. Driver plates
   H. Tool holders
   I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
   A. Steel
   B. Aluminum
   C. Brass

V. Discuss Lathe Safety
   A. Clamping of work
   B. Watches & rings
   C. Housekeeping
   D. Chuck wrenches
   E. Removing chips
   F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
   A. Mounting

B. Removing
C. Aligning

VII. Discuss and Demonstrate Use of Cutting Tools
A. Grinding a toolbit
B. Conditioning point of bits
C. Types of cutting tools

VIII. Discuss and Demonstrate Turning Between Centers
A. Why face cut
B. Center drill
C. Using a tailstock center
E. Using steady rest
F. Using chucks

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe

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Practical Application:

Students will practice in the lab using the lathe. Each student will complete the laboratory exercise prior to preceding to the performance evaluation.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the following components.

1. The student will complete a written evaluation of knowledge items.
2. The student will demonstrate safe operation of the lathe.
3. The student shall fabricate a component to specified tolerance when given a drawing, tools, and equipment. (Refer to figure 1)

Summary:

Review the main lesson points using the objective as a guide. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F6) dealing with the use and care of a drill press.

IMM-F5-LA
Operate Lathes
Attachment 1: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

MASTER Video Tape (IMM-F5-VT1)

"Feeds and Speeds"

IMM-F5-HO
Operate Lathes
Attachment 2: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, Krar, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
45	Component Parts
46	Accessories
47	Feeds and Speeds
48	Safety
49	Mounting and Removing Centers
50	Grinding Lathe Tools
51	Facing Between Centers
52	Machining Between Centers
54	Turning Tapers Using Compound Rest

Module Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile
II. Identify and Discuss Component Parts of an Engine Lathe

A. Control panel
B. Bed & ways
C. Head stock
D. Gear box
E. Carriage
F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
A. Centers
B. Chucks
C. Faceplates
D. Mandrels
E. Steady and follower rest
F. Lathe dogs
G. Driver plates
H. Tool holders
I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
A. Steel
B. Aluminum
C. Brass

V. Discuss Lathe Safety
A. Clamping of work
B. Watches & rings
C. Housekeeping
D. Chuck wrenches
E. Removing chips
F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
A. Mounting
B. Removing
C. Aligning

VII. Discuss and Demonstrate Use of Cutting Tools
A. Grinding a toolbit
B. Conditioning point of bits
C. Types of cutting tools

VIII. Discuss and Demonstrate Turning Between Centers
A. Why face cut
B. Center drill
C. Using a tailstock center
E. Using steady rest
F. Using chucks

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe

IMM-F5-LW1
Operate Lathes
Attachment 3: **MASTER** Laboratory Worksheet

WORK SHEET 1:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Tool grinder
   - Hand tools as required to operate lathe
   - Set of inside and outside micrometers up to 3"
   - Telescoping gages
   - Dial calipers
   - Toolstock
   - Face shield
   - Side shields
   - 3-6" sections of bar stock for practice
   - Drill and sleeve appropriate to hole required
   - Reamer appropriate for hole required
   - Lathe with accessories suitable for project

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises tool grinding:
   A. Grind lathe cutting tool appropriate to metal being turned. **(Instructor must see lathe tool prior to proceeding.)**

5. Practice exercise lathe familiarization.
   A. Student shall practice using lathe controls until familiar.
      (1) Selecting speeds & feeds (use of S & L chart).
      (2) Start and stopping of machine and emergency stop.
      (3) Engage and disengage feed controls.
      (4) Positioning tool in tool holder.
   B. Student shall practice using accessories.
      (1) Centering stock in available chucks.
      (2) Setting up stock between centers.
      (3) Running machine with stock mounted in the chuck.
   C. Lathe operation.
      (1) Practice taking cuts using manual feed
      (2) Practice taking cuts using the engine driven feed and speed controls.
      (3) Practice center drilling.

(4) Practice drilling with the drill bit mounted in the tail stock.
(5) Practice reaming.
(6) Practice cutting a taper using the compound rest (manual feed).

D. Fabricate a part to tolerances specified on the drawing provided.

IMM-F5-LW2
Operate Lathes
Attachment 4: **MASTER** Laboratory Worksheet

WORKSHEET 2:

1. This exercise will combine the skills and knowledge practices in previous lab exercises to fabricate the component described by attachment V.

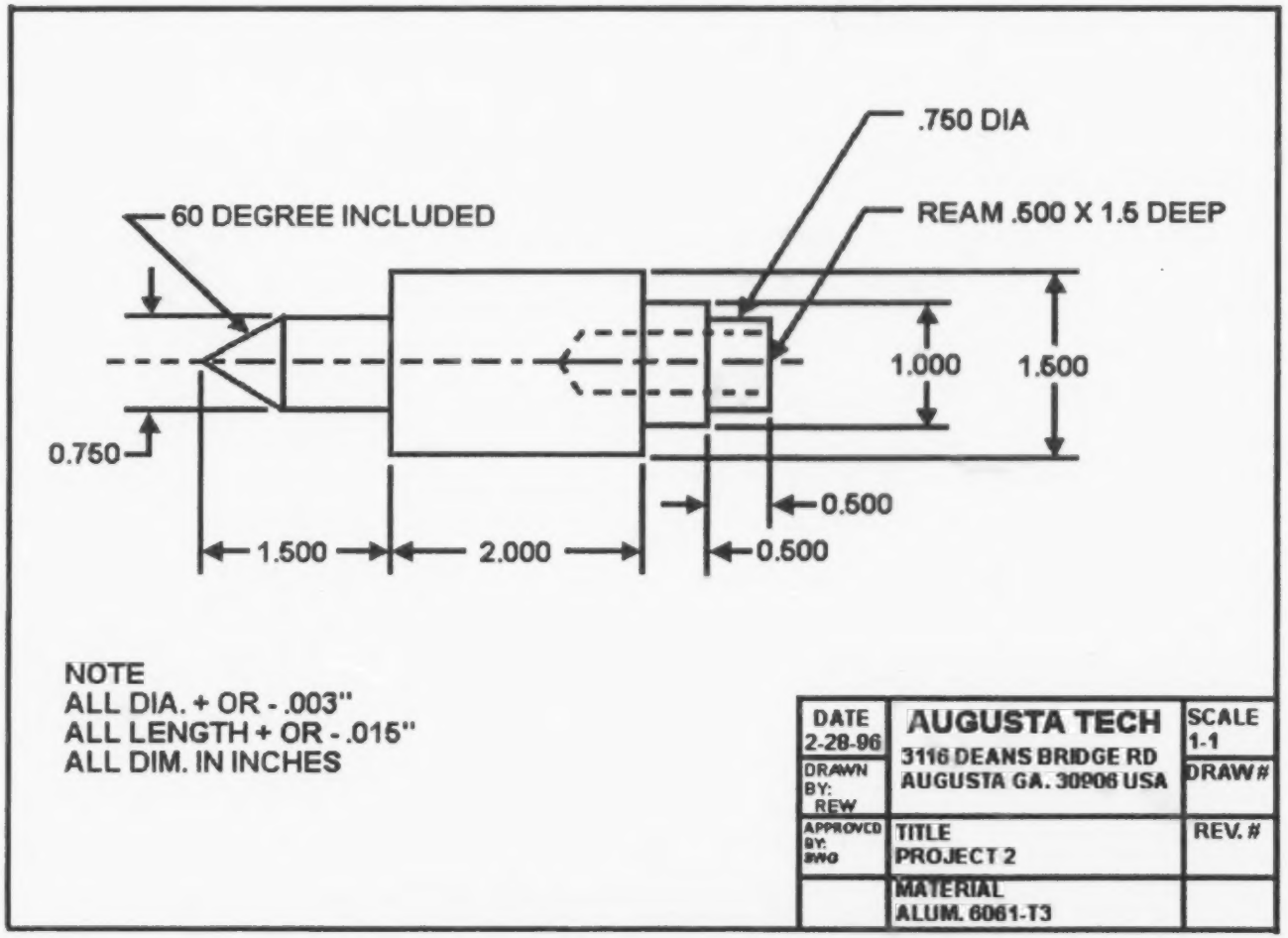
2. Pre-established safety concerns by the drawing.

3. Maintain tolerances by the drawing.

The project will require the student to demonstrate skills and knowledge in the following:

Practice safety
Basic math
Blueprint reading
Measuring instruments
Pedestal grinder operation
Lathe operation

Attachment 5 consists of a drawing of project 2.



INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-F6

Subject: Industrial Maintenance **Time: 40 Hrs.**

Duty: Operate Machine Tools
Task: Use and Care of Drill Press

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Instructional Materials:

MASTER Handout (IMM-F6-HO)
MASTER Laboratory Aid (IMM-F6-LA)
MASTER Laboratory Worksheet (IMM-F6-LW)
MASTER Self-Assessment
Drill Press
Assorted Drills from 9/16" to 1-1/2"
2" stock for practice
Compound Rest
Clamping Dogs
Tools as required for setup
Safety Glasses with side shields
Counter Sink
Reamer

References:

Machine Shop Operations and Setup, Lascoe, Nelson and Porter, American Technical Society, Latest Edition

Machinist Library, Basic Machine Shop, Miller and Brueckman, Audel, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-F5 "Operate Lathes"

Introduction:

One of the most important machines that the machinist may be called on to operate is a drilling machine. The principle of a rotating tool producing a hole in a work piece is very basic to all machine operations. Not only are drill presses used to produce holes, but they are also capable of threading, countersinking, reaming, boring, counterboring, and many other operations necessary for the production of goods in American industry today. Many entry level machine operators and machinists will find their first job to be that of a drill press operator.

Presentation Outline:

I. Identify Major Components
   - A. Bed/table
   - B. Motor
   - C. Speed/feed/directional controls
   - D. Start/stop/emergency stop
   - E. Coolant system
   - F. Drill head
   - G. Column
   - H. Spindle
   - I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
   - A. Speed, feed and directional control
   - B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
   - A. Compound rest
   - B. Clamping dogs
   - C. Tapered shank drill sleeves
   - D. Drill chuck
   - E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
   - A. Hot chips
   - B. Sharp edges

C. Flying derbies

V. Demonstrate the Setup and Safely Operate a Radial Arm Drill Press to a Specified Standard

Practical Application:

The student shall:

1. Practice operating all controls
   - A. Speed, feed and directional control
   - B. Raise, lower and position drill head
2. Practice using all accessories available for the radial arm drill press in use
   - A. Compound rest
   - B. Clamping dogs
   - C. Tapered shank drill sleeves
3. Describe the safety concerns associated with operation of a radial arm drill
   - A. Hot chips
   - B. Sharp edges
   - C. Flying derbies
   - D. High torque rotating equipment
4. Practice the setup and safe operation a radial arm drill to a specified standard

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G1) dealing with the Shielded Metal Arc Welding (SMAW) process.

IMM-F6-HO
Use and Care of Drill Press
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools* by Krar, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
38	Drill Press
39	Drilling Machine Accessories
40	Twist Drills
41	Cutting Speeds and Feeds
42	Drilling Holes
43	Reaming
44	Drill Press Operations

Module Outline:

I. Identify Major Components
   A. Bed/table
   B. Motor
   C. Speed/feed/directional controls

D. Start/stop/emergency stop
E. Coolant system
F. Drill head
G. Column
H. Spindle
I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
A. Speed, feed and directional control
B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
A. Compound rest
B. Clamping dogs
C. Tapered shank drill sleeves
D. Drill chuck
E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
A. Hot chips
B. Sharp edges
C. Flying derbies

V. Demonstrate the Setup and Safely Operate a Radial Arm Drill Press to a Specified Standard

IMM-F6-LA
Use and Care of Drill Press
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

IMM-F6-LW
Use and Care of Drill Press
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The Instructor will:
   - A. Identify major components.
     - (1) Bed/table
     - (2) Motor
     - (3) Speed/feed/directional controls
     - (4) Start/stop/Emergency Stop
     - (5) Coolant system
     - (6) Drill head
     - (7) Column
     - (8) Spindle
     - (9) Radial arm
   - B. Describe the function and demonstrate operations of all controls.
     - (1) Speed, feed and directional control
     - (2) Raise, lower and position drill head
   - C. Describe and demonstrate the use of accessories found on most radial arm drills.
     - (1) Compound rest
     - (2) Clamping dogs
     - (3) Tapered shank drill sleeves
     - (4) Drill chuck
     - (5) Fly cutter
   - D. Describe the safety concerns associated with operation of a radial arm drill.
     - (1) Hot chips
     - (2) Sharp edges
     - (3) Flying derbies
   - E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

2. Student will:
   - A. Identify major components.
     - (1) Bed/table
     - (2) Motor
     - (3) Speed/feed/directional controls
     - (4) Start/stop/Emergency Stop
     - (5) Coolant system
     - (6) Drill head
     - (7) Column

(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges
(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

3. Instructor will grade student on:

A. Identify major components.
(1) Bed/table
(2) Motor
(3) Speed/feed/directional controls
(4) Start/stop/Emergency Stop
(5) Coolant system
(6) Drill head
(7) Column
(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges

(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

Name_____ Date:_____

IMM-F6
Use and Care of Drill Press
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following types of drill presses would be best suited for high volume production parts?
   A. CNC drilling machine
   B. Sensitive drill press
   C. Radial drill press
   D. Gang drilling machine

2. Taper shank twist drills are mounted in the drill press using a _____.
   A. Drill spindle
   B. Drill sleeve
   C. Drill socket
   D. All of the above

3. How is a tapered shank drill removed from a drill press spindle?
   A. With a reversible drill socket
   B. With a drill drift
   C. With a ball peen hammer
   D. With a spindle remover

4. A conventional drill point usually has an included angle of _____.
   A. 60Ķ
   B. 90Ķ
   C. 18Ķ
   D. 135Ķ

5. Which of the following types of drill bits has a removable cutting bit?
   A. A core drill
   B. A gun drill
   C. A spade drill
   D. A variable size drill

6. When a drill bit shows excessive wear at the outer corners of the point, the problem will usually be _____.
   A. Improper web thinning
   B. Cutting lips with unequal angles
   C. Excessive feed
   D. Excessive speed

7. When a drill bit produces a hole which is excessively oversize, the problem will usually be _____.
   A. Improper web thinning
   B. Cutting lips with unequal angles
   C. Cutting lips with unequal lengths
   D. Excessive feed

8. To make it easier for a drill bit to do it's work, which of the following will help greatly?
   A. Thin the web of the drill
   B. Use coolant
   C. Inspect the drill bit
   D. All of the above

9. Which of the following factors affect the rate of feed chosen for a job?
   A. The diameter of the drill
   B. The material of the work piece
   C. The condition of the drilling machine
   D. All of the above

10. As a general rule; for holes up to ½" diameter, allow _____ for reaming and for holes over ½" diameter, allow _____ for reaming.
   A. 1/64" , 1/32"
   B. 1/32" , 1/64"
   C. .100" , .200"
   D. None of the above

11. Which of the following types of taps *cannot* be used with the drill press?
   A. A gun tap
   B. A spiral-fluted tap
   C. A hand tap
   D. A tap drill

12. Which of the following is *not* a valid system of drill sizing?
    A. Fractional drills
    B. Taper drills
    C. Metric drills
    D. Letter drills

IMM-F6
Use and Care of Drill Press
Self-Assessment Answer Key

1. A
2. D
3. B
4. C
5. C
6. D
7. C
8. D
9. D
10. A
11. D
12. B

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-G1

Subject: Industrial Maintenance **Time:** 40 Hrs.

Duty: Perform Welding Operations
Task: Weld with Shielded Metal Arc Welding (SMAW) Process

Objective(s):

Upon completion of this module the student will be able to:
a. Weld with shielded metal arc (SMAW) process.

Instructional Materials:

MASTER Handout (IMM-G1-HO)
MASTER Laboratory Worksheet (IMM-G1-LW)
MASTER Laboratory Aid (IMM-G1-LA)
MASTER Self-Assessment
Basic hand tools
Welding gloves
Chipping hammer
Welding helmet
Wire brush
Constant current welding machine
Ground cable and clamp
Safety glasses
Welding lens (#7-14)
Clear welding lens
Manufacturers' equipment manuals
Material Safety Data Sheet (MSDS)
E6010 electrode
E7018 electrode

References:

Welding Technology, Kennedy, Howard Sams Publishing, Latest Edition
Welding Principles and Practices, Sacks, Bennett Publishing, Latest Edition
Welding and Technology, Little, McGraw-Hill Publishing, Latest Edition
Welding Processes, Griffin, Van Nostrard Publishing, Latest Edition

Weldcare Guide, Brumbaugh, Audel Publishing, Latest Edition
Modern Welding, Althouse, Goodheart Willcox Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-F6 "Use and Care of Drill Press"

Introduction:

At various times the technician must cut and weld parts of the equipment encountered. Although various similarities exist among the processes, specific differences separate the following cutting/welding processes:

A. Oxyacetylene cutting;
B. Carbon arc gouging/cutting;
C. Shielded metal arc welding; and,
D. Gas metal arc welding.

Shielded Metal Arc Welding (SMAW) is a welding process which joins metals by heating them with an arc between a covered metal electrode and the metals being joined. Shielding is obtained from the decomposition (breakdown) of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.

The electric arc flowing across an air gap produces very intense heat and light. An electric arc has been measured at 10,000°F. Considering that steel melts at around 2800°F, the electric arc is indeed a very fast and efficient heat source for melting steel when welding.

Presentation Outline:

I. Machines and Accessories
   A. Selecting the electrode
II. Striking an Arc
III Running Continuous
IV. The Flat Position
   A. The horizontal position
   B. The vertical position
   C. The overhead position
   D. Cast iron
   E. Carbon steels
   F. Alloy steels
   G. Non-ferrous metals

Practical Application:

The student must score 90% on the competency self-assessment and perform a shielded metal arc welding task.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G2) dealing with welding with oxyacetylene.

IMM-G1-HO
Weld with Shielded Metal Arc Welding (SMAW) Process
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:

1. Using OSHA required safety equipment for the shop;
   Safety glasses;
   Hearing protection;
   Face shields;
   Gloves;
2. Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
3. Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Weld with shielded metal arc (SMAW) process.

Reading Assignments:

The following chapters are assigned tor ead from ***Welding Skills and Practices***, by Week, Published by ATS, Latest Edition:

Chapter	Topic
5	Machines and Accessories
6	Selecting the Electrode
7	Striking an Arc
8	Running Continuous Beads
9	The Flat Position
10	The Horizontal Position
11	The Vertical Position
12	The Overhead Position
13	Cast Iron
14	Carbon Steels
15	Alloy Steels
16	Non-Ferrous Metals

Module Outline:

I. Machines and Accessories
   A. Selecting the electrode

II. Striking an Arc
III Running Continuous
IV. The Flat Position
    A. The horizontal position
    B. The vertical position
    C. The overhead position
    D. Cast iron
    E. Carbon steels
    F. Alloy steels
    G. Non-ferrous metals

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

- **A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.**
- **B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.**
- **C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.**
- **D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.**

CAUTION: Electrical shock can be avoided by following specific safety precautions.

- **A. Do not touch live electrical parts.**
- **B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.**
- **C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.**
- **D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.**
- **E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.**
- **F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.**
- **G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.**

H. **Shut off electrical power when working on welding equipment.**

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. **Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.**
B. **Cover all skin surfaces. Keep shirt sleeves rolled down.**
C. **Wear cuffless pants to eliminate spatter traps.**
D. **Wear leather boots. Pant legs should cover boot tops.**
E. **Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.**
F. **For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.**
G. **Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.**
H. **Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.**
I. **Wear a 100% cotton cap to protect the head from sparks or spatter.**
J. **Wear long gauntlet leather gloves.**
K. **Do not touch hot metal with bare hands. Use pliers and wear leather gloves.**
L. **Protect nearby workers from exposure to the welding arc by putting up shields.**
M. **Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).**

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

FIGURE 2 FILTER RECOMMENDATIONS

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

- **A. If possible, weld in specially designated areas or enclosures of noncombustible construction.**
- **B. Remove combustibles from the work area by at least 35 feet if possible.**
- **C. Cover combustibles that cannot be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.**
- **D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.**
- **E. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.**
- **F. Do not weld on materials having either a coating or internal structure that is combustible.**
- **G. Place hot scrap and slag in non-combustible containers.**
- **H. Ensure that fire extinguishers are available nearby.**

I. **Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.**

J. **Follow all company safety procedures regarding welding in hazardous areas.**

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails. DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**
   - Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.
   - Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**
   - Step 1. Choose the proper electrode for the job.

     NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The *E6010* belongs to the *fast-freeze* family of electrodes and the *E7018* belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

     The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.
   - Step 2. Store the electrodes properly.
     - a. Low-hydrogen electrodes:
       - (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.
       - (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: **Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.**

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

FIGURE 5 WELDING ROD POLARITIES

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	--	20-40	20-40	--	--	--	--	--	--
5/64	--	25-60	25-60	--	--	--	--	--	--
3/32	40-80	35-85	45-90	--	--	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

FIGURE 6 TYPICAL CURRENT RANGES FOR ELECTRODES

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:
   (1) Product design
   (2) Material thickness
   (3) Design strength requirements
   (4) Welding process employed

b. SMAW weld joint configuration may be a:
   (1) Lap joint
   (2) Tee joint
   (3) Corner joint
   (4) Edge joint
   (5) Butt joint with backing
   (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing

b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.

a. When making **seam welds**, produce the weld beads by using very little oscillation or some oscillation.

b. When making **fillet welds**, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.

c. When making **groove welds**, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: **a decrease in travel speed** will result in an increase in the weld bead height and width, and an **increase in travel speed** will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip, or
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it (see Figure 7).

Name:_____ Date:_____

IMM-G1
Weld with Shielded Metal Arc Welding (SMAW) Process
Self-Assessment

1. The size of the bead is _____ proportional to the speed of travel.
   A. Directly
   B. Inversely
   C. Not
   D. None of the above

2. The eye shield of the welding helmet should be:
   A. Just light enough to clearly see the arc.
   B. Too dark to clearly see the arc.
   C. A minimum of #5.
   D. None of the above.

3. Welding in confined spaces may require:
   A. Air supplied hoods or hose masks.
   B. Frequent breaks.
   C. Large, high-displacement fans.
   D. All of the above.
   E. None of the above.

4. Long sleeves protect the arms against:
   A. Ultraviolet radiation.
   B. Infrared radiation.
   C, Welding splatter.
   D. All of the above.
   E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   A. Current polarity
   B. Arc length
   C. Length of the electrode
   D. All of the above are variables in the process.
   E. None of the above are variables in the process.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
   A. On.
   B. Off.
   C. On or off, depending on the repair.
   D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes in NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least _____ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____ oscillation.
    A. No
    B. Very little
    C. Moderate
    D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
    A. Do not weld.
    B. Take frequent breaks to inspect the area for fires.
    C. Station a fire watcher near the combustible materials.
    D, Any of the above is acceptable.
    E. None of the above is practical.

21. E7018 electrodes should never be used with:
    A. DC-.
    B. DC+.
    C. AC.
    D. There is no such electrode.

22. Areas to be welded should be thoroughly cleaned:
    A. Prior to fit-up.
    B. By brushing, sanding, or grinding.
    C. With safe solvents.
    D. All of the above, as necessary.
    E. None of the above.

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

24. Low-hydrogen electrodes may be stored:
    A. In sealed cans or heated rod ovens.
    B. Under water.
    C. In petroleum jelly.
    D. Any of the above.
    E. None of the above.

25. As the material being welded increases in thickness, the travel speed of the weld must:

A. Increase.
B. Decrease.
C. Either a or b, depending on the desired effect.
D. Stay the same.
E. None of the above.

IMM-G1
Weld with Shielded Metal Arc Welding (SMAW) Process
Self-Assessment Answer Key

1.	B	16.	B
2.	A	17.	D
3.	A	18.	B
4.	D	19.	C
5.	C	20.	C
6.	E	21.	A
7.	E	22.	D
8.	C	23.	B
9.	B	24.	A
10.	C	25.	B
11.	C		
12.	B		
13.	C		
14.	D		
15.	A		

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-G2

Subject: Industrial Maintenance **Time: 30 Hrs.**

Duty: Perform Welding Operations
Task: Weld/Cut with Oxyacetylene

Objective(s):

Upon completion of this module the student will be able to:

a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

Instructional Materials:

Master Handout (IMM-G2-HO)
Master Laboratory Aid (IMM-G2-LA)
Master Laboratory Worksheet (IMM-G2-LW)
Master Self-Assessment
Oxygen tank
Acetylene tank
Welding torch
MSDS
Safety glasses
Practice metal

References:

Welding Technology, Kennedy, Howard Sams Publishing, Latest Edition
Welding Principles and Practices, Sacks, Bennett Publishing, Latest Edition
Welding and Technology, Little, McGraw-Hill Publishing, Latest Edition
Welding Processes, Griffin, Van Nostrard Publishing, Latest Edition

Weldcare Guide, Brumbaugh, Audel Publishing, Latest Edition
Modern Welding, Althouse, Goodheart Willcox Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-G1 "Weld with Shielded Metal Arc Welding (SMAW) Process"

Introduction:

At various times the technician must cut and weld parts of the equipment encountered. Although various similarities exist among the processes, specific differences separate the following cutting/welding processes:

a. Oxyacetylene cutting;
b. Carbon arc cutting/gouging;
c. Shielded metal arc welding; and,
d. Gas metal arc welding.

This module examines the basics of oxyacetylene cutting/welding. Oxyacetylene cutting requires the use of specific procedures and specific techniques in order to work safely and to produce acceptable cuts. Proper flame adjustments, torch angles, and flame-to-work distances must be maintained in order to produce good cuts. Oxyacetylene cutting can be done from both fixed cutting stations and from portable cutting stations.

Presentation Outline:

I. Gas Cutting Safety
II. Gas Cutting Fundamentals
III. Gasses
IV. Cylinders
V. Regulators
VI. Valves
VII. Oxygen
VIII. Oxygen Hoses
IX. Acetylene
X. Acetylene Hoses
XI. Cutting Torch and Tips
XII. Flame
XIII. Setting Up Equipment
XIV. Light Torch
XV. Cutting Procedure
XVI. Welding Procedure

Practical Application:

You must score 90% on the competency post-test and you must perform oxyacetylene cutting and welding to established standards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G3) dealing with performing gas soldering.

IMM-G2-HO
Weld/Cut with Oxyacetylene
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

READING ASSIGNMENTS:

The following chapters are assigned to read from *Basic Oxyacetylene Welding*, Griffin, Delmar Publishers, Latest Edition.

Chapters	Title
Unit 1	The Oxyacetylene Welding Process
Unit 2	Oxygen and Acetylene Cylinders
Unit 3	Welding Gases
Unit 4	Oxygen and Acetylene Regulators
Unit 5	Types and Uses of Welding Torches
Unit 6	Welding Tips
Unit 7	The Oxyacetylene Welding Flame

Chapters	Title
Unit 9	Flame Cutting
Unit 10	Straight Line Cutting
Unit 11	Bevel Cutting
Unit 12	Piercing and Hole Cutting
Unit 13	Welding Symbols
Unit 14	Running Beads and Observing Effects
Unit 15	Making Beads with Welding Rod
Unit 16	Tacking Light Steel Plate and Making Butt Welds
Unit 17	Flat Corner Welds
Unit 18	Lap Welds on Light Steel Plate
Unit 19	Tee or Fillet Welds on Light Steel Plate
Unit 20	Beads or Welds on Heavy Steel Plate
Unit 21	Manipulation of Welding Rod on Heavy Steel Plate
Unit 22	Butt Welds on Heavy Steel plate
Unit 23	Lap Welds on Heavy Steel Plate
Unit 24	Fillet Welds on Heavy Steel Plate
Unit 25	Beveled Butt Weld on Heavy Steel plate
Unit 26	Backhand Welding on Heavy Steel Plate
Unit 27	Backhand Welding of Beveled but Joints

Module Outline:

I. Gas Cutting Safety
II. Gas Cutting Fundamentals
III. Gasses
IV. Cylinders
V. Regulators
VI. Valves
VII. Oxygen
VIII. Oxygen Hoses
IX. Acetylene
X. Acetylene Hoses
XI. Cutting Torch and Tips
XII. Flame
XIII. Setting Up Equipment

XIV. Light Torch
XV. Cutting Procedure
XVI. Welding Procedure

Caution: **Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.**

a. **Use goggles or shield with a number five shade.**
b. **Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.**
c. **When lighting the torch, direct the torch away from yourself and other personnel.**
d. **Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.**
e. **Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.**
f. **Never cut on containers that have contained flammable or toxic substances.**
g. **Either move work away from or protect wooden or other flammable materials which may be close to the work.**
h. **When cutting, cover concrete floors with sheet metal where sarks and molten metal are being directed.**
i. **Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.**
j. **Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.**
k. **Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.**

Caution: **Handle acetylene and oxygen cylinders carefully:**

a. **Keep acetylene operating pressures at or below 15 psi.**
b. **Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.**
c. **Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.**
d. **Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.**

e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

IMM-G2
Weld/Cut with Oxyacetylene
Attachment 3: **MASTER** Laboratory Worksheet

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of R.B.O.?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.

h. When cutting, cover concrete floors with sheet metal where sparks and molton metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with hand-wheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's *current* contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of R.B.O.
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.

c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
d. Attach the regulators, hoses, torch, and correct-sized torch tip.
e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counter-clockwise until there is a little free play.)
f. Make sure all cutting torch valves are initially closed.
g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
h. Open the acetylene torch valve. Turn the acetylene torch valve off.
I. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. ***Immediately*** light the torch with a ***friction lighter only***.
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the ***neutral*** type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut—assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame

b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.

c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to ½" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.

d. Select the correct torch angle.
   (1) For ***square cuts***, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
   (2) For ***beveled cuts***, the torch should be held at the angle of the bevel throughout the cutting procedure.
   (3) For ***holes***, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the ***correct travel speed***, the lines of the cut which project through the thickness of the base metal will be in a straight line. At ***too fast a travel speed***, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed ***lag*** or ***drag*** lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

Name:_____ Date:_____

IMM-G2
Weld/Cut with Oxyacetylene
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are _____; acetylene fittings are _____.
   a. Red . . . left-handed
   b. Blue . . . left-handed
   c. Red . . . right-handed
   d. Blue . . . left-handed
   e. None of the above is correct.

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following *can* be cut with an oxyacetylene torch?
   a. Aluminum
   b. Copper
   c. Chromium
   d. All of the above
   e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
    a. Clean the nipples with acetone.
    b. Crack the valves to blow out any dirt.
    c. Lubricate the threads with oil.
    d. All of the above
    e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
    a. Wide kerfs.
    b. Adherent slag.
    c. Rough cut appearance.
    d. All of the above.
    e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

16. Lag lines are the result of:
    a. Correct travel speed.
    b. Too great a travel speed.
    c. Too slow a travel speed.
    d. Incorrect torch angle.
    e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
    a. 99.5%.
    b. 95.9%.
    c. 59.9%.
    d. None of the above is correct.

19. Both acetylene and oxygen lines should be _____ when closing down the work station.
    a. Removed
    b. Cleaned with acetone
    c. Bled free of gas or fuel
    d. All of the above
    e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to ½" from the base metal, regardless of the direction of travel. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

IMM-G2
Weld/Cut with Oxyacetylene
Self-Assessment Answer Key

1.	c	11.	d
2.	b	12.	b
3.	b	13.	c
4.	b	14.	d
5.	a	15.	d
6.	d	16.	b
7.	a	17.	a
8.	c	18.	a
9.	a	19.	c
10.	e	20.	c

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-G3

Subject: Industrial Maintenance **Time: 20 Hrs.**

Duty: Perform Welding Operations
Task: Perform Gas Soldering

Objective(s):

Upon completion of this module the student will be able to:

a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Perform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Instructional Materials:

Master Handout (IMM-G3-HO)
Master Laboratory Aid (IMM-G3-LA)
Master Laboratory Worksheet (IMM-G3-LW)
Master Self-Assessment
Oxygen tank
Acetylene tank
Torch
Work materials
Hoses
Goggles (PPE)
Flux for soldering (silver solder)
Flux for brazing (bronze filler rods)
Wire brush
Flame resistant clothing
Welding gloves
Well ventilated work area

References:

Welding Technology, Kennedy, Howard Sams Publishing, Latest Edition

Welding Principles and Practices, Sacks, Bennett Publishing, Latest Edition
Welding and Technology, Little, McGraw-Hill Publishing, Latest Edition
Welding Processes, Griffin, Van Nostrard Publishing, Latest Edition
Weldcare Guide, Brumbaugh, Audel Publishing, Latest Edition
Modern Welding, Althouse, Goodheart Willcox Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-G2 "Weld/Cut with Oxyacetylene"

Introduction:

Brazing is used to make strong joints of good appearance using a bronze filler metal. Brazing is a process in which metals are joined at a temperature greater tan 800 degrees F. A brazed joint is bonded rather than welded.

Presentation Outline:

I. Oxyacetylene Soldering Safety
II. Soldering with Oxyacetylene
III. Equipment Set Up
IV. Light Torch
V. Torch and Rod Control
VI. Soldering with Filter Material
VII. Soldering a But Joint
VIII. Soldering in a Vertical Position

Practical Application:

You must score 90% on the competency post-test and you must perform soldering or bronzing to established standards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H1) dealing with maintaining air conditioning systems.

IMM-G3-HO
Perform Gas Soldering
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Preform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Reading Assignments:

The following chapters are assigned to read from ***Basic Oxyacetylene Welding***, by Griffin, Delmar Publishers, Latest Edition

UNIT	TITLE
Unit 28	Brazing with bronze Rod
Unit 29	Running Beads with Bronze Rod
Unit 30	Square Butt Brazing on Light Steel Plate
Unit 31	Brazed Lap Joints
Unit 32	Brazing Tee Joints
Unit 33	Brazing Beveled butt Joints on Heavy Steel Plate
Unit 34	Building-Up on Cast Iron

Unit 35	Brazing Beveled Joints on Cast Iron
Unit 36	Silver Soldering Nonferrous Metals
Unit 37	Silver Soldering Ferrous and Nonferrous Metals

Module Outline:

I. Oxyacetylene Soldering Safety
II. Soldering with Oxyacetylene
III. Equipment Set Up
IV. Light Torch
V. Torch and Rod Control
VI. Soldering with Filter Material
VII. Soldering a But Joint
VIII. Soldering in a Vertical Position

IMM-G3-LA
Perform Gas Soldering
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-G3-LW
Perform Gas Soldering
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate;
   Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate;
   Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name:_____ Date:_____

IMM-G3
Perform Gas Soldering
Self-Assessment

1. What two conditions determines whether the joint is brazed or welded?

_____

_____

2. How does flux act as a guide to the temperature of the joint?

_____

_____

3. What happens to the color of the plate when it is at the proper temperature for brazing?

_____

_____

4. Is brazing stronger than fusion welding?

_____

5. For silver soldering, what is a 3x flame?

_____

6. What alloys are contained in typical silver soldering?

_____

7. How can material be prepared for silver soldering?

_____

_____

8. Is it possible to make fillets when using silver soldering alloys?

_____

IMM-G3
Perform Gas Soldering
Self-Assessment Answer Key

1. Brazed joint uses adhesion rather cohesion. A brazed joint is bonded.
2. When flux melts and flow freely.
3. Plate changes color when ready for brazing.
4. No
5. Carburizing flame.
6. Copper, silver, phosphorus.
7. Wire brushing, rub with emery cloth or steel wool, or dip in acid bath.
8. No

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working shift	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H1

Subject: Industrial Maintenance **Time: 60 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Maintain Air Conditioning Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how psychrometries are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Instructional Materials:

MASTER Handout (IMM-H1-HO)
MASTER Laboratory Aid (IMM-H1-LA)
MASTER Laboratory Worksheet (IMM-H1-LW)
MASTER Self-Assessment
HVAC system
HVAC instrumentation
HVAC test equipment

References:

Commercial Refrigeration, Anderson, Audel Publishers, Latest Edition
Principles of Refrigeration, Dossat, Prentice Hall Publishers, Latest Edition
Basic Refrigeration, Langley, Reston Publishers, Latest Edition
Refrigeration: Home and Commercial, Palmquist, Audel Publishers, Latest Edition
Refrigeration and Air Conditioning Technology, Whitman, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-G3 "Perform Gas Soldering"

Introduction:

HVAC provides climate control of a designated environment. This is very common in many industrial plants today for better control of product and personnel working in this environment. It is so common that it has become accepted as a part of life for many plants. The maintenance mechanic is required to know and maintenance this complex system.

Presentation Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation
IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems

Practical Application:

1. Instructor will demonstrate selection and proper use of HVAC equipment.
2. Students will be allowed to practice the use of HVAC equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H2) dealing with maintaining and troubleshooting pneumatic control circuits

IMM-H1-HO
Maintain Air Conditioning Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wear rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how phychrometrics are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Reading Assignments:

The following chapters are assigned to read from ***Air Conditioning and Refrigeration Compressors***, TPC Publishers, Latest Edition:

Lesson	Title
1	Compressors
4	Control and Protective Devices
5	Maintenance and Repair

Module Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation

IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H1-LW
Maintain Air Conditioning Systems
Attachment 3: MASTER Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

2. Student will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

3. Instructor will grade students ability to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

Name:_____ Date:_____

IMM-H1
Maintain Air Conditioning Systems
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following could cause the oil in a compressor to be low?
   a. Compressor is burning oil
   b. Oil has vaporized
   c. Oil is trapped in the system
   d. All of the above

2. To repair a leaking gasket on a compressor, the first step is to:
   a. Remove the part that the gasket seals
   b. Check the bolt torque
   c. Clean off the compressor
   d. Pump down the compressor

3. What can you use to clean dirt and oxidation from starter and control contacts?
   a. Special contact cleaning solvents
   b. Vacuum cleaner
   c. R-11
   d. Soap and water

4. On three-phase motors, the imbalance between phases should be no greater than:
   a. 2%
   b. 5%
   c. 10%
   d. 20%

5. Which of the following parts can you probably replace without removing the compressor from the system?
   a. Head gasket
   b. Suction valve
   c. Terminal plate gasket
   d. All of the above

6. If the compressor starts to make a pounding noise during pumpdown, it is probably:
   a. Pumped down enough
   b. Slugging oil
   c. Ready for new valves
   d. Leaking oil

7. Copper plating on internal compressor parts indicates that:
   a. The compressor is slugging oil
   b. The compressor is low on oil
   c. The system contains moisture or acids
   d. The compressor is slugging refrigerant

8. After cleaning the compressor parts, check the tolerance, roundness, taper of crankpin, and bearing journals using a:
   a. Micrometer
   b. Straightedge
   c. Feeler gage
   d. Plug gage

9. Which of the following could cause a compressor motor cookout?
   a. Oversized overload protector
   b. Welded overload contractor
   c. Frequent resetting of overload protector
   d. All of the above

10. Which of the following parts would you install in a system to clean out contaminants from a mild burnout using the operating method?
   a. Suction line filter-drier
   b. Liquid line filter-drier
   c. System cleaner
   d. All of the above

IMM-H1
Maintain Air Conditioning Systems
Self-Assessment Answer Key

1. C
2. B
3. A
4. A
5. D
6. B
7. C
8. A
9. D
10. B

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H2

Subject: **Industrial Maintenance** **Time: 4 Hrs.**

Duty: **Maintain/Troubleshoot Equipment and Systems**
Task: Maintain Pneumatic Control Circuits

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Instructional Materials:

MASTER Handout (IMM-H2-HO)
MASTER Laboratory Aid (IMM-H2-LA)
MASTER Laboratory Worksheet (IMM-H2-LW)
MASTER Self-Assessment
Shutoff valve
Check valve
One-way valve
Two-way valve
Three-way valve
Four-way valve
Quick-release valve
Maintenance
A. General
B. Disassemble and rework
Basic circuit

References:

Mechanics' and Millwrights' Guide, Carl Nelson, MacMillan Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H1 "Maintain Air Conditioning Systems"

Introduction:

Pneumatic circuits are quick and usually more powerful than electrical control devices. Air also is less likely to cause sparks or explosions. Air is used in environments that are somewhat explosive.

Presentation Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
    A. General
    B. Disassemble and rework
IX. Basic Circuit

Practical Application:

Student will work with pneumatic control circuits and pneumatic components.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Self-Assessment.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H3) dealing with troubleshooting centrifugal pumps.

IMM-H2-HO
Maintain Pneumatic Control Circuits
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:.
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power*, by Parker Publishers, Latest Edition:

Chapter	Title
5	Energy Transmission Using A Pneumatic System
11	Simple Pressure Control Valves

Module Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
  A. General
  B. Disassemble and rework
IX. Basic Circuit

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Practice Disassembling:

1. Shut-Off Valve
2. Check Valve
3. One-Way Valve
4. Two-Way Valve
5. Three-Way Valve
6. Four-Way Valve
7. Quick-Release Valve
8. Maintenance
   - A. General
   - B. Disassemble and rework
9. Basic Circuit

Name:_____ Date:_____

IMM-H2
Maintain Pneumatic Control Circuits
Self-Assessment

1. The action produced by compressed air is _____.
   a. smooth.
   b. easily converted into a rate.
   c. erratic.
   d. never reciprocal.

2. When you decrease the volume of confined air, pressure _____.
   a. increases.
   b. decreases.
   c. remains the same.

3. When you decrease the volume of confined air, heat _____
   a. increases.
   b. decreases.
   c. remains the same.

4. A compressor piston is powered by a _____.
   a. surge of energy.
   b. prime shaker.
   c. prime mover.
   d. nuclear turbine.

5. Air outside the compressor is known as _____.
   a. vacuum.
   b. ambient.
   c. standard.
   d. potentially noxious.

6. The connecting point of a compressor piston _____ force.
   a. concentrates
   b. diminishes
   c. magnifies
   d. None of the above.

7. The displacement of air in a working pneumatic system indicates a constant _____ of energy.
   a. build-up
   b. waste
   c. misunderstanding
   d. expenditure

8. Air ceases to flow when its pressure _____.
   a. divides.
   b. multiplies.
   c. equalizes.
   d. peaks.

9. Compressors are used to _____.
   a. compress metals for recycling.
   b. convert atmospheric air into a useful power source.
   c. regulate air pressure in a plant air system.
   d. reduce the amount of air in the system.

10. The purpose of the oil injector is to
   a. inject oil into the compressor motor.
   b. speed up the flow of air in the pipes.
   c. provide a source of lubrication to pneumatic power tools.
   d. remove oil from the system.

IMM-H2
Maintain Pneumatic Control Circuits
Self-Assessment Answer Key

1. c
2. a
3. a
4. c
5. b
6. a
7. d
8. c
9. b
10. c

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H3

Subject: **Industrial Maintenance** **Time: 20 Hrs.**

Duty: **Maintain/Troubleshoot Equipment and Systems**
Task: Troubleshoot Centrifugal Pumps

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal pumps;.
f. Demonstrate the installation of a centrifugal pump;.
g. Set-up and operate a centrifugal pump safely;.
h. Identify problems by troubleshooting centrifugal pumps;.
i. Describe maintenance and repair of centrifugal pumps;.
j. Demonstrate corrosion resisting centrifugal pumps; and,.
k. Describe impeller design consideration.

Instructional Materials:

MASTER Handout (IMM-H3-HO)
MASTER Laboratory Aid (IMM-H3-LA)
MASTER Laboratory Worksheet (IMM-H3-LW)
MASTER Self-Assessment
Centrifugal pump
Hand tools

References:

Mechanics' and Millwrights' (Audel), Carl A. Nelson, Macmillan Computer Company, Latest Edition
Centrifugal Pumps Design and Applications, Lobanoff and Ross, Gulf Publishing Company, Latest Edition
Pumps, Schoolcraft Publishing, Latest Edition
Video: *Maintaining Centrifugal Pumps,* Tel-a-Train, 309 North Market Street, P. O. Box 4752, Chattanooga, TN 37405, Latest Edition

Video: ***Pump Maintenance Procedures,*** Goulds Model 3196 ANSI Process Pump, Goulds Pump, Inc., 240 Fall Street, Seneca Falls, NY 13148, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H2 "Maintain Pneumatic Control Circuits"

Introduction:

Due to the importance of moving fluids in manufacturing, construction and even providing water for everyday usage, pumps are extremely important. This lesson pertains to the centrifugal pump, its safe operations, installation, set-up, troubleshooting, and repair.

Presentation Outline:

I. Describe the Principles of Hydraulics
   - A. Introduction
   - B. Basic principles
   - C. Static head
   - D. Static lift
   - E. Displacement
   - F. Buoyancy
   - G. Hydrostatic paradox
   - H. Hydrostatic balance

II. Describe Hydrodynamics and Water Flow
   - A. Dynamic head
   - B. Dynamic lift
   - C. Total column
   - D. Friction of water in pipes
   - E. Measurement of water flow
   - F. Siphon
   - G. Flow through orifices
   - H. Specific gravity
   - I. Summary

III. Describe the Operation of a Centrifugal Pump
   - A. Basic principles
   - B. Straight vane pumps
   - C. Curved vane pumps
   - D. Volute (curve)
   - E. Effects of the curvature

IV. Discuss the Classifications of Centrifugal Pump

A. Single-stage
B. Multistage
C. Impellers
D. Balancing

V. Identify and Describe the Parts of a Centrifugal Pump
A. House or casting
B. Impeller
C. Stuffing box assembly
D. Bearings and housing
E. Shaft assembly
F. Drive

VI. Demonstrate the Installation of a Centrifugal Pump
A. Location
B. Foundation
C. Leveling-aligning
D. Grouting
E. Inlet pipe
F. Discharge pipe
G. High temperature material pumping

VII. Set-Up and Operate a Centrifugal Pump
A. First check
1. Rotation
2. Lubrication
3. Bearing cooling water
4. Inspect all parts
B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations

A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head

Practical Application:

1. Set-up and operate a centrifugal pump.
2. Troubleshoot a centrifugal pump.
3. Stop the centrifugal pump.
4. Disassemble, replace needed parts, and reassemble the centrifugal pump.
5. Reinstall the centrifugal pump.
6. Operate and troubleshoot the centrifugal pump.
7. Repeat steps 1 through 6 on other types of centrifugal pumps.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H4) dealing with troubleshooting positive displacement pumps.

IMM-H3-HO
Troubleshoot Centrifugal Pumps
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal;
f. Demonstrate the installation of a centrifugal pump;
g. Set-up and operate a centrifugal pump safely;
h. Identify problems by troubleshooting centrifugal pumps;
i. Describe maintenance and repair of centrifugal pumps;
j. Demonstrate corrosion resisting centrifugal pumps; and,
k. Describe impeller design consideration.

Reading Assignments:

The following chapters are assigned to read from ***Pumps***, Stewart/Miller and Macmillian, Audel Publishing Company, Latest Edition:

Chapter	Title
2	Principles of Hydraulics
3	Centrifugal Pumps

Module Outline:

I. Describe the Principles of Hydraulics
   A. Introduction

B. Basic principles
C. Static head
D. Static lift
E. Displacement
F. Buoyancy
G. Hydrostatic paradox
H. Hydrostatic balance

II. Describe Hydrodynamics and Water Flow
A. Dynamic head
B. Dynamic lift
C. Total column
D. Friction of water in pipes
E. Measurement of water flow
F. Siphon
G. Flow through orifices
H. Specific gravity
I. Summary

III. Describe the Operation of a Centrifugal Pump
A. Basic principles
B. Straight vane pumps
C. Curved vane pumps
D. Volute (curve)
E. Effects of the curvature

IV. Discuss the Classifications of Centrifugal Pump
A. Single-stage
B. Multistage
C. Impellers
D. Balancing

V. Identify and Describe the Parts of a Centrifugal Pump
A. House or casting
B. Impeller
C. Stuffing box assembly
D. Bearings and housing
E. Shaft assembly
F. Drive

VI. Demonstrate the Installation of a Centrifugal Pump
A. Location
B. Foundation
C. Leveling-aligning
D. Grouting
E. Inlet pipe
F. Discharge pipe
G. High temperature material pumping

VII. Set-Up and Operate a Centrifugal Pump
A. First check

1. Rotation
2. Lubrication
3. Bearing cooling water
4. Inspect all parts

B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations
A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head

IMM-H3-LA
Troubleshoot Centrifugal Pumps
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical object;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Set-up and operate a centrifugal pump;
   c. Troubleshoot a centrifugal pump;
   d. Stop the centrifugal pump;
   e. Disassemble, replace needed parts, reassemble the centrifugal pump;
   f. Reinstall the centrifugal pump;
   g. Operate and troubleshoot the centrifugal pump; and,
   h. Repeat steps a. through g. on other types of centrifugal pumps.

IMM-H3-LW
Troubleshoot Centrifugal Pumps
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will observe the safe and proper procedures for the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

2. Student will:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump;
   f. Operate and troubleshoot the centrifugal pump; and,
   g. Repeat steps a. through f. on other types of centrifugal pumps.

3. Instructor will grade student's performance on the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

Name:_____ Date:_____

IMM-H3
Troubleshoot Centrifugal Pumps
Self-Assessment

Circle the letter preceding the most correct answer.

1. The roughness of a wall of a long pipe, fittings and elbows is called _____ head.
   a. Velocity
   b. Empty
   c. Friction
   d. Static

2. The flow of water inside a centrifugal pump is from _____.
   a. Left to right
   b. Right to left
   c. Out to center
   d. Center out

3. To insure economical and satisfactory pumping operations the proper type of _____ selection is important.
   a. Impeller
   b. Casting
   c. Stuffing box
   d. Shaft assembly

4. If a long inlet pipe must be used the pipe should be _____.
   a. Made of galvanized pipe
   b. Made of black iron
   c. Larger that the inlet
   d. Smaller that the inlet

5. Most centrifugal pumps should not be run dry, therefore it must be _____ before running.
   a. Sealed
   b. Primed
   c. Oiled
   d. Leveled

6. When starting a pump with oil lubricated bearings, it should be _____.
   a. Drained of water
   b. Warmed with heaters
   c. Run dry for five minutes
   d. Rotated by turning the rotor, by hand, several times

7. If the pump fails to discharge, check to see if _____.
   a. There are leaks in the suction line
   b. The motor is misaligned
   c. The suction or discharge valves are closed
   d. There are leaks in the stuffing box

8. If the pump fails to discharge, check to see if _____.
   a. The direction of rotation is wrong
   b. Air or vapor is in the liquid
   c. The speed is too slow
   d. The shaft is bent

9. If the pump discharges and then stops; check to see if _____.
   a. Direction of rotation is wrong
   b. Supply level is too high
   c. The lift is too high
   d. There are leaks in the suction line

10. If the pump is noisy or vibrates check to see if _____.
    a. The lift is too high
    b. There is a misalignment
    c. The supply level is too low
    d. The pump is primed

11. When tightening the flange nuts allowance for lateral movement must be _____ inches for small pumps.
    a. 1/4
    b. 1/8
    c. 1/64
    d. .003

12. The corrosion resisting pumps are usually made of two materials which are noryl or _____.
    a. Brass
    b. Polypropylene
    c. Cast iron
    d. Mild steel

13. If a corrosion resisting pump motor will not hum or rotate check _____:
    a. The main power box for blown fuse, etc.
    b. For foreign materials inside the pump
    c. For leaking seal
    d. For low fluid supply

14. If a corrosion resisting pump loses prime check _____:
    a. For improper line voltage
    b. Thermal overload on the motor
    c. For clogged inlet port and/or impeller
    d. For leaking seal

15. If disassembly of a corrosion resisting pump is necessary the first step should be _____:
    a. Remove the ceramic piece from the impeller
    b. Removing the carbon graphite seals from the front of the body
    c. Detaching the body from the motor
    d. Shut off power to the motor

IMM-H3
Troubleshoot Centrifugal Pumps
Self-Assessment Answer Key

1. C
2. D
3. A
4. C
5. B
6. D
7. C
8. A
9. D
10. B
11. C
12. B
13. A
14. D
15. D

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H4

Subject: Industrial Maintenance **Time: 20 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot Positive Displacement Pumps

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rotary pumps;
b. Describe the construction of rotary pumps;
c. Demonstrate the installation and operation of rotary pumps;
d. Identify problems in troubleshooting rotary pumps;
e. Describe rotary pump calculations;
f. Describe the principles of operation of a reciprocating pump;
g. Describe the construction of a reciprocating pump;
h. Perform reciprocating pump calculations; and,
i. Identify and describe special service pumps.

Instructional Materials:

MASTER Handout (IMM-H4-HO)
MASTER Laboratory Aid (IMM-H4-LA)
MASTER Laboratory Worksheet (IMM-H4-LW)
MASTER Self-Assessment
Vane pump
Piston pump
Lift pump
Self priming pump
Hand tools

References:

Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Computer Publishing, Latest Edition
Centrifugal Pumps Design and Applications, Lobanoff and Ross, Gulf Publishing Company, Latest Edition
Pumps, Schoolcraft Publishing Company, Latest Edition

Video: ***Maintaining Centrifugal Pumps***, Tel-A-Train's Mechanical Maintenance Training Series, 309 North Market Street, P. O. Box 4752, Chattanooga, TN 37405, Latest Edition

Video: ***Pump Maintenance Procedures***, Goulds Model 3196 ANSI Process Pump, Goulds Pump, Inc., 240 Fall Street, Seneca Falls, NY 13148, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H3 "Troubleshoot Centrifugal Pumps"

Introduction:

Due to importance of moving fluids in manufacturing, construction and even providing water for everyday usage, pumps are extremely important. This lesson pertains to the positive displacement pump, its safe operations, installation, setup, troubleshooting, and repair.

Presentation Outline:

I. Describe the Principles of Operation of Rotary Pumps
   - A. Gear-type pumps
   - B. Vane-type pumps
   - C. Piston-type pumps

II. Describe the Construction of Rotary Pumps
   - A. Gear-type pumps
   - B. Vane-type pumps
   - C. Piston-type pumps

III. Demonstrate the Installation and Operation of Rotary Pumps
   - A. Introduction of installation
   - B. Alignment
   - C. Drives for rotary gear pumps
   - D. Power for driving pumps
   - E. Piping
   - F. Direction of rotating
   - G. Starting and operating the pump
   - H. Practical installation
   - I. Types of gear pumps
   - J. Pressure relief valve

IV. Identify Problems in Troubleshooting Rotary Pumps
   - A. No liquid delivered
   - B. Insufficient liquid delivered
   - C. Pump delivers for a short period, then quits

D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency

IX. Identify and Describe Special Service Pumps
A. Introduction to special service pumps
B. Chemical and process pumps
C. Pumps for handling of sewage
D. Magma pumps
E. Sump pumps
F. Irrigation pumps
G. Diaphragm type pumps
H. Shallow and deep well pumps
I. Turbine pumps
J. Rubber impeller pumps
K. Tubing pumps

Practical Application:

1. Set-up and operate a positive displacement pump.
2. Troubleshoot a positive displacement pump.

3. Stop the positive displacement pump.
4. Disassemble, replace needed parts, reassemble the positive displacement pump.
5. Reinstall the positive displacement pump.
6. Operate and troubleshoot the positive displacement pump.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H5) dealing with maintaining gate, globe, ball, plug and butterfly valves.

IMM-H4-HO
Troubleshoot Positive Displacement Pumps
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Set-up and operate a positive displacement pump;
b. Troubleshoot a positive displacement pump;
c. Stop the positive displacement pump;
d. Disassemble, replace needed parts, reassemble the positive displacement pump;
e. Reinstall the positive displacement pump; and,
f. Operate and troubleshoot the positive displacement pump.

Reading Assignments:

The following chapters are assigned to read from *Pumps (Audel)*, Stewart/Miller, Macmillian Publishing Company, Latest Edition

Chapter	Title
4	Rotary Pumps
5	Reciprocating Pumps
6	Special Service Pumps

Module Outline:

I. Describe the Principles of Operation of Rotary Pumps
   A. Gear-type pumps
   B. Vane-type pumps
   C. Piston-type pumps
II. Describe the Construction of Rotary Pumps

A. Gear-type pumps
B. Vane-type pumps
C. Piston-type pumps

III. Demonstrate the Installation and Operation of Rotary Pumps
A. Introduction of installation
B. Alignment
C. Drives for rotary gear pumps
D. Power for driving pumps
E. Piping
F. Direction of rotating
G. Starting and operating the pump
H. Practical installation
I. Types of gear pumps
J. Pressure relief valve

IV. Identify Problems in Troubleshooting Rotary Pumps
A. No liquid delivered
B. Insufficient liquid delivered
C. Pump delivers for a short period, then quits
D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency

IX. Identify and Describe Special Service Pumps

- A. Introduction to special service pumps
- B. Chemical and process pumps
- C. Pumps for handling of sewage
- D. Magma pumps
- E. Sump pumps
- F. Irrigation pumps
- G. Diaphragm type pumps
- H. Shallow and deep well pumps
- I. Turbine pumps
- J. Rubber impeller pumps
- K. Tubing pumps

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop.
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H4-LW
Troubleshoot Positive Displacement Pumps
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

2. Student will:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

3. Instructor will grade the student's performance on:
   a. Set-up and operation of a positive displacement pump;
   b. Troubleshooting a positive displacement pump;
   c. Stopping the positive displacement pump;
   d. Disassembling, replacing needed parts, reassembling the positive displacement pump;
   e. Reinstalling the positive displacement pump; and,
   f. Operating and troubleshooting the positive displacement pump.

Name:_____ Date:_____

IMM-H4
Troubleshoot Positive Displacement Pumps
Self-Assessment

Circle the letter preceding the most correct answer.

1. The rotary pump differs from the centrifugal pump because the rotary pump _____.
   a. Has a rotating action
   b. Uses a single valve impeller
   c. Uses a positive displacement
   d. Has a two stroke action

2. The three types of rotary pumps are _____, _____, and _____ types.
   a. Gear, piston, tubing
   b. Gear, vane, piston
   c. Diaphragm, tubing, piston
   d. Diaphragm, gear, jet

3. There are _____ types of spur gear rotary pumps.
   a. 8
   b. 6
   c. 4
   d. 2

4. The rotary pump that can withstand rugged operating conditions, simple in construction, economical and have fewer working parts is the _____ type pump.
   a. Gear
   b. Piston
   c. Vane
   d. Force

5. After correctly aligning the rotary pump the _____ may then prevent the transmission of end thrust and compensate for slight changes in alignment during normal operation.
   a. Pump bearings
   b. Pump gasket
   c. Pump base
   d. Flexible coupling

6. If no liquid is being delivered by the rotary pump the first step is to _____.
   a. Increase the RPM
   b. Check for air leak in inlet line
   c. Check for oil in the stuffing box
   d. Flexible coupling

7. If there is insufficient liquid delivery check for _____.
   a. Air leak in inlet line or stuffing box
   b. Speed too fast
   c. Lift too low
   d. Coupling bearing out of balance

8. A 4000 gallon tank must be filled in two hours; the size pump required would be _____ GPM.
   a. 15
   b. 20
   c. 25
   d. 70

9. A reciprocating pump is classified as a _____ or _____ type pump.
   a. Rotary, centrifugal
   b. Lift, force
   c. Vane, gear
   d. Spur, impeller

10. Reciprocating pumps are designed with _____ or _____ or _____ or _____ plungers.
   a. 5, 7, 8, 10
   b. 5, 6, 7, 8
   c. 3, 5, 7, 9
   d. 2, 4, 6, 8

11. A double action, high pressure, horizontal duplex reciprocating piston pump is considered a _____ pump of special service pumps.
   a. Centrifugal
   b. Sewage
   c. Chemical
   d. Service

12. The pump that uses a flexible substance such as rubber is called a _____ type pump.
    a. Centrifugal
    b. Diaphragm
    c. Piston
    d. Vane

13. The water in a shallow well should be less than _____ feet.
    a. 22
    b. 47
    c. 88
    d. 125

IMM-H4
Troubleshoot Positive Displacement Pumps
Self-Assessment Answer Key

1. C
2. B
3. B
4. A
5. D
6. D
7. A
8. C
9. B
10. C
11. D
12. B
13. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H5

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Maintain Gate, Globe, Ball, Plug, and Butterfly Valves

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain gate valves;
b. Maintain globe valves;
c. Maintain ball valves;
d. Maintain plug valves; and,
e. Maintain butterfly valves.

Instructional Materials:

MASTER Handout (IMM-H5-HO)
MASTER Laboratory Aid (IMM-H5-LA)
MASTER Laboratory Worksheet (IMM-H5-LW)
MASTER Self-Assessment
Gate valve
Globe valve
Ball valve
Plug valve
Butterfly valve
Hand tools

References:

Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Computer Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H4 "Troubleshoot Positive Displacement Pumps"

Introduction:

Valves control fluid and air flow. They control both the amount and the direction of flow. This phenomenon is important in maintaining power consistency and application.

Presentation Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement

Practical Application:

Students will operate valves and learn to perform common maintenance in order to prolong the life of the valves.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluations.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H6) dealing with maintaining check valves and relief valves.

IMM-H5-HO
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain gate valve;
b. Maintain globe valve;
c. Maintain ball valve;
d. Maintain plug valve; and,
e. Maintain butterfly valve.

Reading Assignments:

The following chapters are assigned to read from *Piping Systems*, Schoolcraft Publishers, Latest Edition:

Chapter	Title
7	Common Valves

Module Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking.

IMM-H5-LW
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

2. Student will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

3. Instructor will grade student's ability to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

Name:_____ Date:_____

IMM-H5
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Self-Assessment

1. Describe how gate valve works.

2. Describe how globe valve works.

3. Describe how ball valve works.

4. Describe how plug valve works.

5. Describe how butterfly valve works.

IMM-H5
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Self-Assessment Answer Key

1. Valve has a disk or plate that endures a translational motion in a plane transverse to the flow passage or valve body.

2. Valve has a disk or plug which is forced into a seat. Angle of tapered mating surface depends on valve size. Valve has globular external shape.

3. Has a solid ball with a diametric hole through it which can be rotated within a spherical seat. Ball is rotated so side lines up with inlet port to allow flow.

4. Shut off valve containing a tapered rod with a laterial hole through it. By rotating rod, flow can be controlled.

5. Consists of a disk that is rotated to control flow.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H6

Subject: Industrial Maintenance **Time: 6 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Maintain Check Valves and Relief Valves

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain check valve; and,
b. Maintain relief valve.

Instructional Materials:

MASTER Handout (IMM-H6-HO)
MASTER Laboratory Aid (IMM-H6-LA)
MASTER Laboratory Worksheet (IMM-H6-LW)
MASTER Self-Assessment
Check valve
Relief valve
Hand tools

References:

Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Computer Publishing, Latest Edition
Piping Systems, Schoolcraft Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H5 "Maintain Gate, Globe, Ball, Plug, and Butterfly Valves"

Introduction:

Valves control fluid and/or air flow.

Presentation Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement

Practical Application:

Student will practice common maintenance procedures on check valves and relief valves.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide to discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H7) dealing with troubleshooting and repairing blowers.

IMM-H6-HO
Maintain Check Valves and Relief Valves
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participate in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain check valve; and,
b. Maintain relief valve.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems***, Schoolcraft Publishers, Latest Edition

Chapter	Title
7	Common Valves

Module Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H6-LW
Maintain Check Valves and Relief Valves
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

2. Student will demonstrate how to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

3. Instructor will grade student's ability to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

Name:_____ Date:_____

IMM-H6
Maintain Check Valves and Relief Valves
Self-Assessment

1. Describe purpose of check valve.
   _____
   _____
   _____

2. Describe purpose of relief valve.
   _____
   _____
   _____

3. The valve body is usually made of _____.

4. The valve cover is usually a _____.

5. The relief valve may be the _____ type, or the _____ type, or the _____ type.

IMM-H6
Maintain Check Valves and Relief Valves
Self-Assessment Answer Key

1. Allows fluids to flow in only one direction.

2. If pressure increases above present value, valve will open.

3. Iron, aluminum or bronze.

4. Casting or a screw, machine part.

5. Direct acting, direct operated pilot, or remote operated pilot.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H7

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot and Repair Blowers

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot blowers; and,
b. Repair blowers.

Instructional Materials:

MASTER Handout (IMM-H7-HO)
MASTER Laboratory Aid (IMM-H7-LA)
MASTER Laboratory Worksheet (IMM-H7-LW)
MASTER Self-Assessment
Blowers
Hand tools
Multimeter

References:

Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Computer Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H6 "Maintain Check Valves and Relief Valves"

Introduction:

Blowers move air at a rapid pace. This air movement aids in combustion content, cooling, induced draft or forced air applications.

Presentation Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers

Practical Application:

Students will use blowers for different applications. Students will maintain and troubleshoot blowers.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H8) dealing with troubleshooting, maintaining, and repairing hydraulic systems.

IMM-H7-HO
Troubleshoot and Repair Blowers
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Troubleshoot blowers; and,
b. Repair blowers.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Motor Control***, Alerich, Delmar Publishers, Latest Edition:

Chapter	Title
48	Motor

Module Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-H7-LW
Troubleshoot and Repair Blowers
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

2. Student will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

3. Instructor will grade student's ability to:
   Troubleshoot blowers; and,
   Repair blowers.

Name:_____ Date:_____

IMM-H7
Troubleshoot and Repair Blowers
Self-Assessment

1. List troubleshooting steps.

_____

_____

_____

_____

2. List replacement steps.

_____

_____

_____

_____

3. Define CFM.

_____

_____

_____

_____

4. How does blade angle affect CFM?

_____

_____

_____

_____

5. **How are blowers used in industry?**

IMM-H7
Troubleshoot and Repair Blowers
Self-Assessment Answer Key

1. Isolation
   Sectionalize

2. Device must be dismantled so part can be removed. Reverse procedures to install new part.

3. Cubic fast per minute

4. Blade angle can increase or decrease CPM. If there is more contact with air this will increase the CFM.

5. Blowers are used to cool fluid or materials.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H8

Subject: Industrial Maintenance **Time: 40 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot, Maintain, and Repair Hydraulic Systems

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot hydraulic system;
b. Maintain hydraulic system; and,
c. Repair hydraulic system.

Instructional Materials:

MASTER Handout (IMM-H8-HO)
MASTER Laboratory Worksheet (IMM-H8-LW)
MASTER Laboratory Aid (IMM-H8-LA)
MASTER Self-Assessment
Hydraulic trainer

References:

ABCs of Hydraulic Circuits, Harry Stewart, Sams Company, Latest Edition
Handbook of Hydraulics, Horace Williams, McGraw-Hill Publishers, Latest Edition
Hydraulic Systems Analysis, John Stringer, Wiley Co., Latest Edition
Flow Control, William S. Buzzard, ISA Publishers, Latest Edition
Davis' Handbook of Applied Hydraulics, Vincent Zipparro, McGraw-Hill Publishers, Latest Edition
Mechanics of Fluids, Herman Shames, McGraw-Hill Publishers, Latest Edition
Fluid Power and Control Systems, Ernest Fitch, Jr., McGraw-Hill Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H7 "Troubleshoot and Repair Blowers"

Introduction:

With hydraulic power, one is able to move large objects. Hydraulic power is large but moves slow. Hydraulic power moves large loads in industry.

Presentation Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

Practical Application:

1. Instructors will demonstrate how to troubleshoot, maintain and repair hydraulic systems.
2. Student will demonstrate how to troubleshoot, maintain and repair hydraulic systems.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H9) dealing with troubleshooting, maintaining, and repairing pneumatic systems.

IMM-H8-HO
Troubleshoot, Maintain, and Repair Hydraulic Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Troubleshoot hydraulic system;
b. Maintain hydraulic system; and
c. Repair hydraulic system.

Reading Assignments:

The following chapters are assigned to read from ***Fluid Power 1***, by Parker Publishers, Latest Edition:

Chapter	Title
3	Energy Transmission Using a Hydraulic System
4	Control of Hydraulic Energy
7	Hydraulic Pumps
8	Check Valves, Cylinders and Motors
10	Directional Control Valves
12	Pilot Operated Pressure Control Valves

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H8-LW

Troubleshoot, Maintain, and Repair Hydraulic Systems

Attachment 3: **MASTER** Laboratory Worksheet

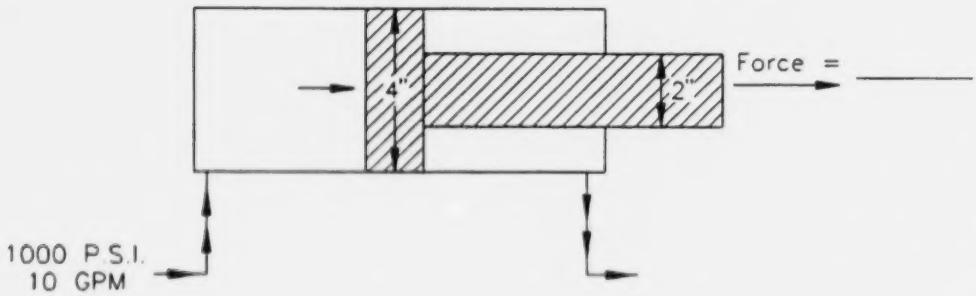
Worksheet:

1. Student will practice:
   a. Troubleshooting hydraulic system;
   b. Maintaining hydraulic system; and,
   c. Repairing hydraulic system.

2. Instructor will grade student's performance.

Name:_____ Date:_____

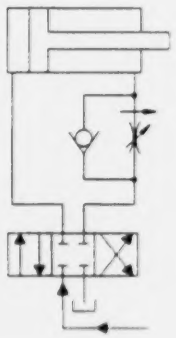
IMM-H8
Troubleshoot, Maintain, and Repair Hydraulic Systems
Self-Assessment



1. In the above diagram, what is the force generated (disregard friction)?
   A. 14560 lbs
   B. 13560 lbs
   C. 12560 lbs
   D. 11560 lbs

2. At what speed is the cylinder moving?
   A. 184 inches per minute
   B. 17 feet per minute
   C. Either A or B
   D. Neither A or B

3. This diagram shows a:
   A. Unworkable circuit.
   B. Meter-in circuit.
   C. Meter-in, meter-out circuit.
   D. Meter-out circuit.



A system malfunction has been traced to a bad pump. In addition to replacing the pump, one should also:

A. Replace the relief valve.
B. Adjust the main control valve.
C. Adjust the cylinder packing.
D. Find out what caused the pump to fail.

5. Cavitation occurs in a pump when:

A. The fluid does not completely fill the space provided for it in the pump.
B. The pressure from the output causes the pump to cease pumping action.
C. The flow from the pump cannot be increased by increasing the RPM.
D. The inlet is too large, allowing too much oil to the pump.

IMM-H8
Troubleshoot, Maintain, and Repair Hydraulic Systems
Self-Assessment Answer Key

1. C
2. D
3. A
4. D
5. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-H9

Subject: Industrial Maintenance **Time: 40 Hrs.**

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot, Maintain, and Repair Pneumatic Systems

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Instructional Materials:

MASTER Handout (IMM-H9-HO)
MASTER Laboratory Worksheet (IMM-H-9-LW)
MASTER Laboratory Aid (IMM-H-9-LA)
MASTER Self-Assessment
Directional control valves
Relief valve
Tubing
Compressor

References:

Fluid Power, Parker Publishing, Latest Edition
Industrial Pneumatic Technology, Parker Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H8 "Troubleshoot, Maintain, and Repair Hydraulic Systems"

Introduction:

Pneumatic systems are used to control HVAC systems, cleaning, cutting, turning, mixing, moving and many other industrial and business application.

Presentation Outline:

I. Pneumatic Theory
II. Compressor
III. Regulators
IV. Valves
V. Actuators
VI. Safety
VII. Prevention Maintenance
VIII. Troubleshooting Pneumatic Devices
IX. Repair Pneumatic Devices

Practical Application:

Student will practice with a working pneumatic system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I1) dealing with maintaining and troubleshooting belt drive systems.

IMM-H9-HO
Troubleshoot, Maintain, and Repair Pneumatic Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power 1*, by Parker Publisher, Latest Edition:

Chapters	Title
5	Energy Transmission Using A Pneumatic System
11	Simple Pressure Control Valves

Module Outline:

I. Pneumatic Theory
II. Compressor
III. Regulators
IV. Valves
V. Actuators
VI. Safety
VII. Prevention Maintenance
VIII. Troubleshooting Pneumatic Devices
IX. Repair Pneumatic Devices

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H9-LW
Troubleshoot, Maintain, and Repair Pneumatic Systems
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Draw a circuit utilizing a single acting cylinder, gravity return, as the load. Use a directional control valve. Make the cylinder extend. Have the instructor approve the diagram. Construct the circuit. Have the instructor approve the circuit. Run the circuit.

2. Same as Problem #1, except use double acting cylinder.

3. Practice PM on an existing pneumatic system.. Instructor will go over typical PM procedures.

4. Same as Problem #1, except use meter-out circuit.

5. Same as Problem #1, except use a quick exhaust circuit.

Name:_____ Date:_____

IMM-H9
Troubleshoot, Maintain, and Repair Pneumatic Systems
Self-Assessment

Circle the letter preceding the correct answer.

1. If a force exerted by a piston of 9 $in.^2$ area is 2430 pounds, the pressure on the piston is _____ pounds per square inch.
   a. 2430
   b. 1215
   c. 270
   d. 30

2. Which of the following elements is basic to a complete pneumatic system?
   a. Filters
   b. Tank Storage and Conditioning Equipment
   c. Pressure Gauges
   d. Thermal Sensors

3. The first step in troubleshooting a problem in a pneumatic system is to _____:
   a. Check the fluid level in the reservoir.
   b. List the symptoms.
   c. Study the system's recent history.
   d. Shut down the malfunctioning equipment.

4. The first item to check when you are troubleshooting a pneumatic system is the _____.
   a. Machine's production rate.
   b. Time of the last overhaul.
   c. Operator's opinion.
   d. Supply air pressure.

5. Which of the following should be checked if a control valve is inoperative? (pneumatics)
   a. Exhaust Muffler
   b. Pilot Pressure
   c. Valve Actuator
   d. All of the above.

6. If a water-cooled compressor has a closed system, it means _____.
   a. The water is recirculated.
   b. The compressor is sealed as a unit.
   c. The compressor requires no external cooling.
   d. The compressor must be operated indoors.

7. How is the cylinder of a single-acting, air-oil system returned to its starting position?
   a. Gravity
   b. External Load
   c. Return Air-Oil Pressure
   d. Gravity or External Load

IMM-H9
Troubleshoot, Maintain, and Repair Pneumatic Systems
Self-Assessment Answer Key

1. c
2. b
3. d
4. c
5. c
6. a
7. d

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

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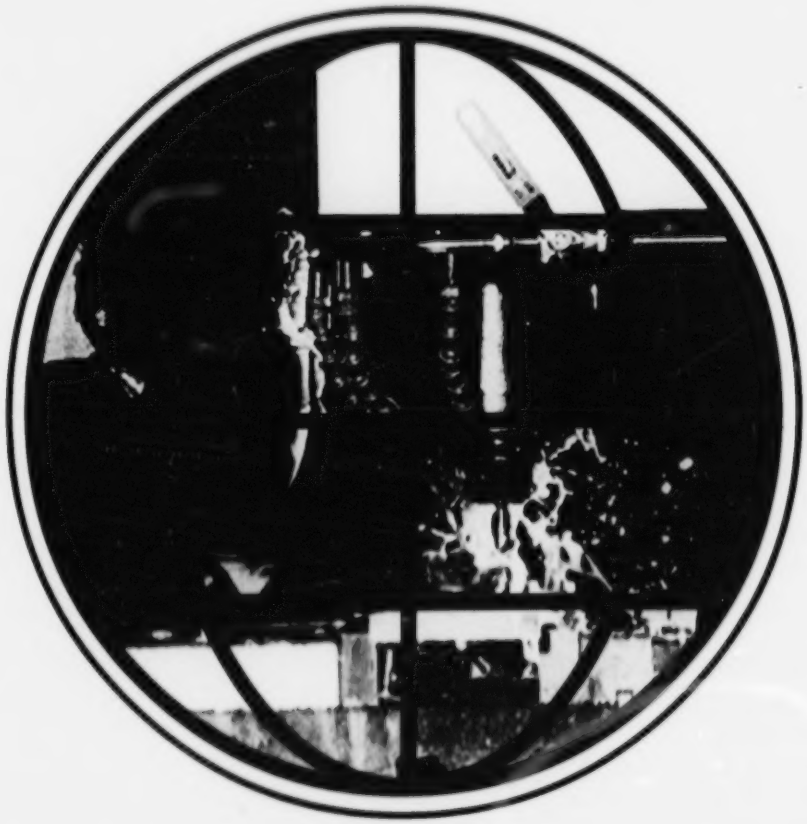

Industrial Maintenance Series

INSTRUCTOR'S HANDBOOK

DUTIES I THROUGH S

624

Supported by the National Science Foundation's Advanced Technological Education Program

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

Duty I

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-I1

Subject: Industrial Maintenance **Time: 7 Hrs.**

Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Belt Drive Systems

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Instructional Materials:

MASTER Handout (IMM-I1-HO)
MASTER Laboratory Worksheet (IMM-I1-LW)
MASTER Laboratory Aid (IMM-I1-LA)
MASTER Self-Assessment
Belt drives (assortment)

References:

Mechanical Trades Pocket Manual, Latest Edition
Mechanics' and Millwrights' Guide (Audel), Carl Nelson, MacMillan Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H9 "Troubleshoot, Maintain, and Repair Pneumatic Systems"

Introduction:

Belt drives provide a means of transferring mechanics energy from a motor to a driven component.

Presentation Outline:

I. Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V. Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX. Belt Replacement

Practical Application:

1. Student will learn how to maintain a belt drive system.
2. Student will learn how to troubleshoot a belt drive system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I2) dealing with maintaining and troubleshooting gear power transmission drives.

IMM-I1-HO
Maintain and Troubleshoot Belt Drive Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Reading Assignments:

The following chapters are assigned to read from *Industrial Motor Control*, Alerich, Delmar Publishers, Latest Edition

Chapter	Title
60	Pulley Drives

Module Outline:

I. Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V. Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX. Belt Replacement

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-I1-LW
Maintain and Troubleshoot Belt Drive Systems
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

2. Student will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

3. Instructor will grade student's ability to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

Name:_____ Date:_____

IMM-I1
Maintain and Troubleshoot Belt Drive Systems
Self-Assessment

1. The correct tension for a belt is _____.
   a. as tight as possible.
   b. found in the equipment manual.
   c. dependent on the number of belts on the drive.
   d. impossible to maintain without an idler pulley.

2. The preferred method for adjusting belt tension is to _____.
   a. move the pulleys closer or farther apart.
   b. use an idler pulley.
   c. Both a. and b.
   d. None of the above.

3. The section of a V-belt that contains the cords is the _____.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

4. The section of a V-belt that is in the shape of a wedge is the _____.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

5. The section of a V-belt that stretches as the belt wraps around a pulley is _____.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

6. When one belt breaks in a three-belt set, how many belts are needed to repair the drive?
   a. one
   b. two
   c. three
   d. four

Use the following information to answer questions 7 through 10.

The drive pulley is eight inches in diameter. It turns at 1800 rpm (revolutions per minute). The driven pulley is 36 inches in diameter. The pulleys are 25 inches apart (center to center).

7. What is the speed of the driven pulley?
   a. 400 rpm
   b. 900 rpm
   c. 1,800 rpm
   d. 8,100 rpm

8. What is the length of the belt on this drive?
   a. 94 inches
   b. 119 inches
   c. 188 inches
   d. None of the above.

9. What is the pulley ratio?
   a. 4 to 9
   b. 8 to 18
   c. 1 to 18
   d. 1 to 288

10. What is the driven shaft speed if the drive shaft is slowed to 900 rpm?
   a. 200 rpm
   b. 450 rpm
   c. 1,800 rpm
   d. 900 rpm

11. What is the purpose of a multi-belt arrangement?
   a. to increase the speed of the drive
   b. to increase the ratio the drive can handle
   c. to increase the amount of power the drive can transmit
   d. All of the above.

12. When a flat belt on a conveyor is riding to one side, you should
   a. increase the speed of the belt.
   b. level the conveyor.
   c. adjust the end rollers.
   d. None of the above.

13. _____ is a way to connect the ends of a flat belt.
    a. Gluing
    b. Weaving
    c. Vulcanizing
    d. All of the above.

14. Most belts are made from a combination of
    a. rubber, glass, and cloth.
    b. rubber, rubber-like fabric, and cords.
    c. glass, cloth, and cords.
    d. None of the above.

15. One pulley in a automatically adjusting variable-speed pulley arrangement must be a
    a. manually adjusting variable-speed pulley.
    b. normal one-speed pulley.
    c. pneumatically adjusting variable-speed pulley.
    d. spring-loaded adjusting pulley.

IMM-I1
Maintain and Troubleshoot Belt Drive Systems
Self-Assessment Answer Key

1. b
2. a
3. b
4. c
5. a
6. c
7. a
8. b
9. a
10. a
11. c
12. c
13. d
14. b
15. d

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-I2

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Gear Power Transmission Drives

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Instructional Materials:

MASTER Handout (IMM-I2-HO)
MASTER Laboratory Worksheet (IMM-I2-LW)
MASTER Laboratory Aid (IMM-I2-LA)
MASTER Self-Assessment
Gear drive assortment

References:

Modern General Shop, W. C. Brown, et al., Goodheart-Willcox Publishers, Latest Edition
General Metals, J. L. Feirer, McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, R. A. Kibbe, et al, John Wiley & Sons Publishers, Latest Edition
Machine Tool Operations: An Introduction, S. R. Matt, Wadsworth Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I1 "Maintain and Troubleshoot Belt Drive Systems"

Introduction:

Gear drives offer the highest transfer of energy. Gears are used on many types of industrial machines.

Presentation Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting

Practical Application:

1. Student will be able to compare spur gear to bevel gear.
2. Student will be able to perform maintenance in a spur gear.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I3) dealing with maintaining and troubleshooting chain power transmission drives.

IMM-I2-HO
Maintain and Troubleshoot Gear Power Transmission Drives
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
6	Gears

Module Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I2-LW
Maintain and Troubleshoot Gear Power Transmission Drives
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

2. Student will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

3. Instructor will grade student's ability to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

Name:_____ Date:_____

IMM-I2
Maintain and Troubleshoot Gear Power Transmission Drives
Self-Assessment

1. What is a spur gear?

_____

_____

_____

2. What is a bevel gear?

_____

_____

_____

3. What is a herringbone gear?

_____

_____

_____

4. What is a ring and pinion gear?

_____

_____

_____

5. List three (3) common maintenance techniques for gear.

_____

_____

_____

6. Compare spur gear to bevel gear.

_____

_____

_____

IMM-I2
Maintain and Troubleshoot Gear Power Transmission Drives
Self-Assessment Answer Key

1. A spear gear has straight teeth, cut parallel with the axis of rotation.

2. a. Bevel gear is cut at 45 degrees.
   b. Over gears are conical gears.
   c. (One supplies) Usually used to connect shafts that have connecting axis.

3. Double helical=herringbone

4. This gear has teeth on a horizontal plan.

5. 1. Proper lubrication
   2. Cleanliness
   3. Replace when show signs of wear

6. Helical gears have teeth cut along a helical surface.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-I3

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Chain Power Transmission Drives

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain chain power transmission drives; and,
b. Troubleshoot chain driven power transmission drives.

Instructional Materials:

MASTER Handout (IMM-I3-HO)
MASTER Laboratory Worksheet (IMM-I3-LW)
MASTER Laboratory Aid (IMM-I3-LA)
MASTER Self-Assessment
Chain assortment

References:

Modern General Shop, W. C. Brown, et al., Goodheart-Willcox Publishers, Latest Edition
General Metals, J. L. Feirer, McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, R. A. Kibbe, et al., John Wiley & Sons Publishers, Latest Edition
Machine Tool Operations: An Introduction, S. R. Matt, Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I2 "Maintain and Troubleshoot Gear Power Transmission Drives"

Introduction:

Chain drives are more powerful than belt drives, but not as powerful as gear drives.

Presentation Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains

Practical Application:

1. Student will be able to identify single link chains.
2. Student will be able to identify double link chains.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I4) dealing with maintaining and troubleshooting clutches.

IMM-I3-HO
Maintain and Troubleshoot Chain Power Transmission Drives
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain chain power transmission drives; and,
b. Troubleshoot chain driven power transmission drives.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
7	Chain Drives

Module Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I3-LW
Maintain and Troubleshoot Chain Power Transmission Drives
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

2. Student will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

3. Instructor will grade student's ability to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

Name:_____ Date:_____

IMM-I3
Maintain and Troubleshoot Chain Power Transmission Drives
Self-Assessment

1. When a sprocket becomes worn and its teeth are hooked or leaning,
   a. the drive is misaligned.
   b. the sprocket is not the same size as the chain.
   c. the chain is worn.
   d. All of the above.

2. The advantage chain drives have over belt drives is
   a. they are not damaged by oil and grease.
   b. they can withstand higher temperatures.
   c. they do not slip on their sprockets.
   d. All of the above.

3. A roller link is made up of
   a. one side bar, two rollers, and two bushings.
   b. two side bars, two rollers, and two pins.
   c. two side bars, two rollers, and two bushings.
   d. two side bars, two rollers, and one bushing.

4. A chain with a pitch of one inch is a number
   a. 40 chain.
   b. 80 chain.
   c. 100 chain.
   d. 200 chain.

5. The chain best suited for applications where noise reduction is most important is
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.

6. The chain that has tabs on its side bars is a
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.

7. The chain that has lubricant sealed in at the factory is a/an
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.

8. Chain tension should be
   a. as tight as possible.
   b. just enough slack to allow the slack side to touch the tight side.
   c. just enough to allow flexing by hand.
   d. loose enough to allow the operator to remove the chain without adjusting tension.

9. On roller chain, the areas needing lubrication are between the
   a. rollers and bushings.
   b. pins and bushings.
   c. side bars.
   d. All of the above.

10. Roller chain should be replaced
   a. when it is rusty.
   b. every time the drive is worked on.
   c. every six months.
   d. All of the above.

IMM-I3
Maintain and Troubleshoot Chain Power Transmission Drives
Self-Assessment

1. c
2. d
3. c
4. b
5. a
6. b
7. d
8. c
9. d
10. a

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-I4

Subject: **Industrial Maintenance** **Time: 8 Hrs.**

Duty: **Repair Power Transmission Systems**
Task: Maintain and Troubleshoot Clutches

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain clutches; and,
b. Troubleshoot clutches.

Instructional Materials:

MASTER Handout (IMM-I4-HO)
MASTER Laboratory Worksheet (IMM-I4-LW)
MASTER Laboratory Aid (IMM-I4-LA)
MASTER Self-Assessment
Clutch assortment

References:

Modern General Shop, W. C. Brown, et al., Goodheart-Willcox Publishers, Latest Edition
General Metals, J. L. Feirer, McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, R. A. Kibbe, et al., John Wiley & Sons Publishers, Latest Edition
Machine Tool Operations: An Introduction, S. R. Matt, Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I3 "Maintain and Troubleshoot Chain Power Transmission Drives"

Introduction:

Clutches allow variable control of speed from zero to full speed.

Presentation Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly

Practical Application:

1. Student will be able to maintain hydraulic clutches.
2. Student will be able to maintain pneumatic clutches.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J1) dealing with layout of sheet metal parts.

IMM-I4-HO
Maintain and Troubleshoot Clutches
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain clutches; and,
b. Troubleshoot clutches.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
3	Mechanical Power Transmission

Module Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I4-LW
Maintain and Troubleshoot Clutches
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly
   - B. Troubleshoot:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly

2. Student will demonstrate how to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly
   - B. Troubleshoot:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly

3. Instructor will grade student's ability to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch

(5) Pneumatic clutch
(6) Clutch-brake assembly

B. Troubleshoot:
(1) Clutch
(2) Mechanical clutch
(3) Electrical clutch
(4) Hydraulic clutch
(5) Pneumatic clutch
(6) Clutch-brake assembly

Name:_____ Date:_____

IMM-I4
Maintain and Troubleshoot Clutches
Self-Assessment

1. _____ is used to engage and disengage a jaw clutch.
   a. A friction plate
   b. A shift arm
   c. A release fork
   d. A ball bearing

2. A spring-action clutch is disengaged by a/an
   a. engage/disengage collar.
   b. drive keyway.
   c. shift lever.
   d. special release bearing.

3. The basic function of a clutch is to _____ _____.

4. The basic parts of a clutch are the _____ member and the _____ member.

5. The four general categories of clutches are _____, _____, _____, and _____.

6. Three types of friction clutches are _____, _____, and _____.

7. The majority of mechanical clutches are _____ clutches.

8. Jaw clutches are also called _____ _____ clutches.

9. Mechanical clutches are often actuated _____.

10. A _____ controls the tension between the drive and driven members in a jaw clutch with a slip feature.

IMM-I4
Maintain and Troubleshoot Clutches
Self-Assessment Answer Key

1. b
2. d
3. transmit torque
4. drive, driven
5. mechanical, electrical, hydraulic, pneumatic
6. Any three of the following:
   spring-action; wedge-action; centrifugal force; overrunning
7. friction
8. positive contact
9. manually
10. spring

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

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655 Duty J

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INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadhseet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-J1

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Fabricate/Install Sheet Metal Parts
Task: Layout Sheet Metal Parts

Objective(s):

Upon completion of this module the student will be able to:

a. Identify sheet metal sizes and products;
b. Describe sheet metal patterns and patternmaking; and,
c. Describe sheet metal and wire size.

Instructional Materials:

MASTER Handout (IMM-J1-HO)
MASTER Laboratory Worksheet (IMM-J1-LW)
MASTER Laboratory Aid (IMM-J1-LA)
MASTER Self-Assessment
Tools and materials necessary to complete the projects

References:

Sheet Metal Work (Audel) John D. Bies, Mcmillan Publishing Company, Latest Edition
Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Publishing Company, Latest Edition
Sheet Metalwork, John Nagle, Bergwall Productions, Inc. Garden City, New York, 11530, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6	"Practice Safety" series
IMM-B1 through IMM-B6	"Apply Mathematical Concepts" series
IMM-C1 through IMM-C3	"Interpret Engineering Drawings and Control Documents" series
IMM-D1 through IMM-D2	"Use Measuring Tools" series
IMM-E1 through IMM-E2	"Use Hand Tools" series

IMM-F1 through IMM-F6	"Operate Machine Tools" series
IMM-G1 through IMM-G3	"Perform Welding Operations" series
IMM-H1 through IMM-H9	"Maintain/Troubleshoot Equipment and Systems" series
IMM-I1 through IMM-I4	"Repair Power Transmission Systems" series

Introduction:

Sheet metal work is a very important part of our every day lives. We find use in our homes in a variety of appliance, heating and air conditioners. We travel to work in cars, busses and air planes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the basic layout of sheet metal parts.

Presentation Outline:

I. Identify Sheet Metal Sizes and Products
   - A. Sizes
   - B. Products

II. Describe Sheet Metal Patterns and Patternmaking
   - A. Introduction
   - B. Types of pattern development
   - C. Hem and seam allowances on patterns
   - D. Bending sequence
   - E. Bend allowance

III. Describe Sheet Metal and Wire Sizes
   - A. Sheet metal and wire gages
   - B. Manufacturers' standard gages and sheet steel
   - C. Brown and Sharp or American Standard gage

Practical Application:

1. Practice making parallel line pattern of a rectangular pan
   - a. Use necessary drawing tools
   - b. Use necessary tools and materials for safe assembly
2. Practice making parallel line development for a cylinder
   - a. Use necessary drawing tools
   - b. Use necessary tools and materials for safe assembly
3. Practice making parallel line development of a truncated cylinder
   - a. Use necessary drawing tools
   - b. Use necessary tools and materials for a safe assembly

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J2) dealing with forming and/or bending sheet metal parts.

IMM-J1-HO
Layout Sheet Metal Parts
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal sizes and products;
b. Describe sheet metal patterns and patternmaking; and,
c. Describe sheet metal and wire size.

Reading Assignments:

The following chapters are assigned to read from ***Metal Technology and Practice,*** Pepp/MeCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

Chapters	**Title**
8	Sheet Metal Processing

Module Outline:

I. Identify Sheet Metal Sizes and Products
   A. Sizes
   B. Products
II. Describe Sheet Metal Patterns and Patternmaking
   A. Introduction
   B. Types of pattern development
   C. Hem and seam allowances on patterns
   D. Bending sequence
   E. Bend allowance
III. Describe Sheet Metal and Wire Sizes

A. Sheet metal and wire gages
B. Manufacturers' standard gages and sheet steel
C. Brown and Sharp or American Standard gage

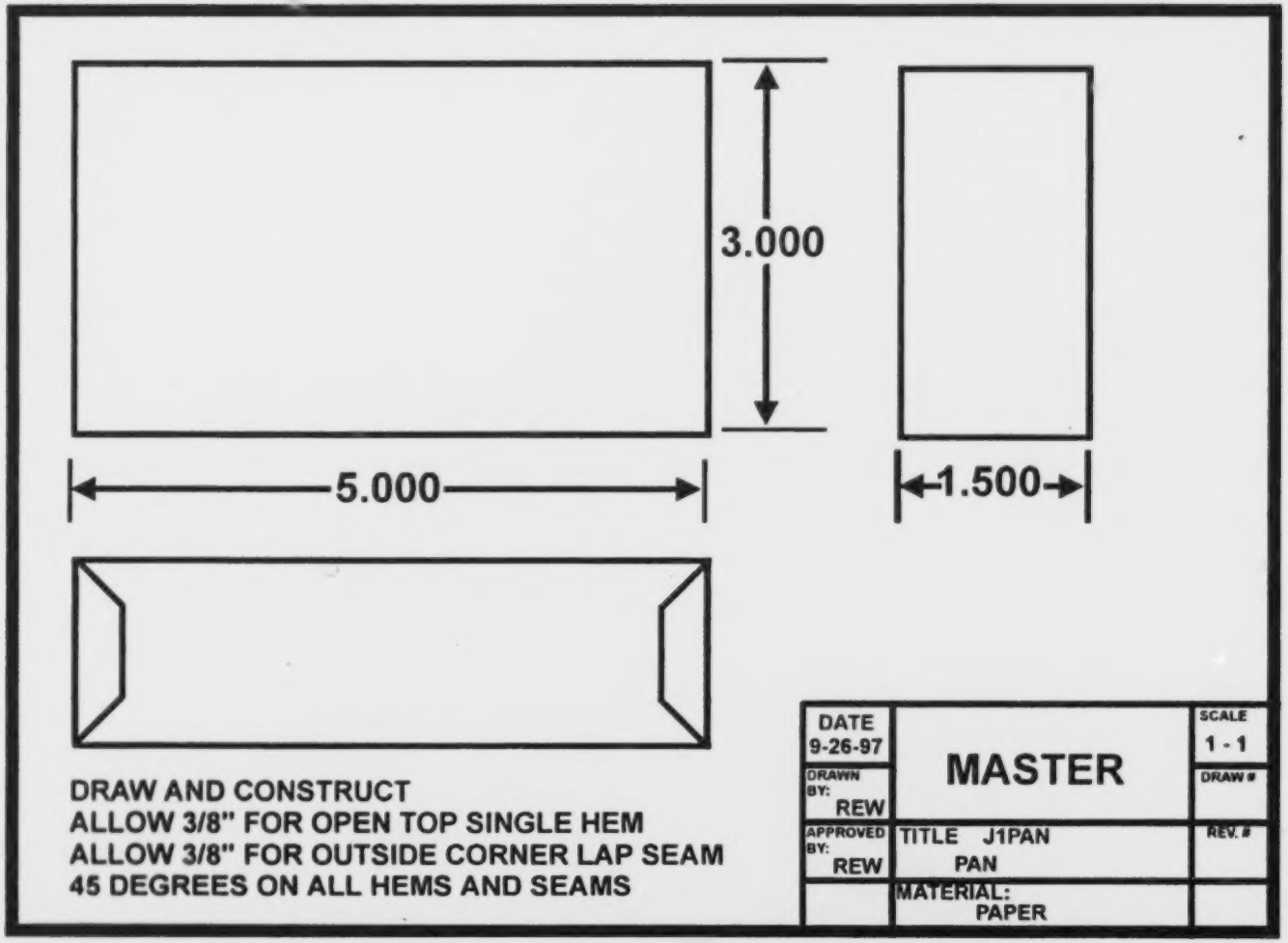
IMM-J1-LA
Layout Sheet Metal Parts
Attachment 2: **MASTER** Laboratory Aid

1. Instructor will:
   a. Demonstrate the proper layout procedures for sheet metal layout;
   b. Insure proper tools are availble for layout;
   c. Insure proper tools are construction of project are available;
   d. Insure proper techniques are used for layout; and,
   e. Insure proper techniques are used in safely constructing the projects.

2. Student will:
   a. Layout and construct sheet metal patterns on paper;
   b. Practice making parallel line pattern of a rectangular pan;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   c. Practice making parallel line development for a cylinder;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   d. Practice making parallel line development of a truncated cylinder;
      (1) Use necessary drawing tools; and,
      (2) Use necessary tools and materials for a safe assembly.

SHEET METAL AND WIRE GAGE DESIGNATION

GAGE NO.	AMERICAN OR BROWN & SHARPE'S A.W.G. OR B&S	UNITED STATES STANDARD	MANUFACTURERS' STANDARD FOR SHEET METAL	GAGE NO.
0000000	....	.500	....	0000000
000000	.5800	.469	....	000000
00000	.5165	.438	....	00000
0000	.4600	.406	....	0000
000	.4096	.375	....	000
00	.3648	.344	....	00
0	.3249	.312	....	0
1	.2893	.281	....	1
2	.2576	.266	....	2
3	.2294	.250	.2391	3
4	.2043	.234	.2242	4
5	.1819	.219	.2092	5
6	.1620	.203	.1943	6
7	.1443	.188	.1793	7
8	.1285	.172	.1644	8
9	.1144	.156	.1495	9
10	.1019	.141	.1345	10
11	.0907	.125	.1196	11
12	.0808	.109	.1046	12
13	.0720	.0938	.0897	13
14	.0642	.0781	.0747	14
15	.0571	.0703	.0673	15
16	.0508	.0625	.0598	16
17	.0453	.0562	.0538	17
18	.0403	.0500	.0478	18
19	.0359	.0438	.0418	19
20	.0320	.0375	.0359	20
21	.0285	.0344	.0329	21
22	.0253	.0312	.0299	22
23	.0226	.0281	.0269	23
24	.0201	.0250	.0239	24
25	.0179	.0219	.0209	25
26	.0159	.0188	.0179	26
27	.0142	.0172	.0164	27
28	.0126	.0156	.0149	28
29	.0113	.0141	.0135	29
30	.0100	.0125	.0120	30
31	.0089	.0109	.0105	31
32	.0080	.0102	.0097	32
33	.0071	.00938	.0090	33
34	.0063	.00859	.0082	34
35	.0056	.00781	.0075	35
36	.0050	.00703	.0067	36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DRAW AND CONSTRUCT
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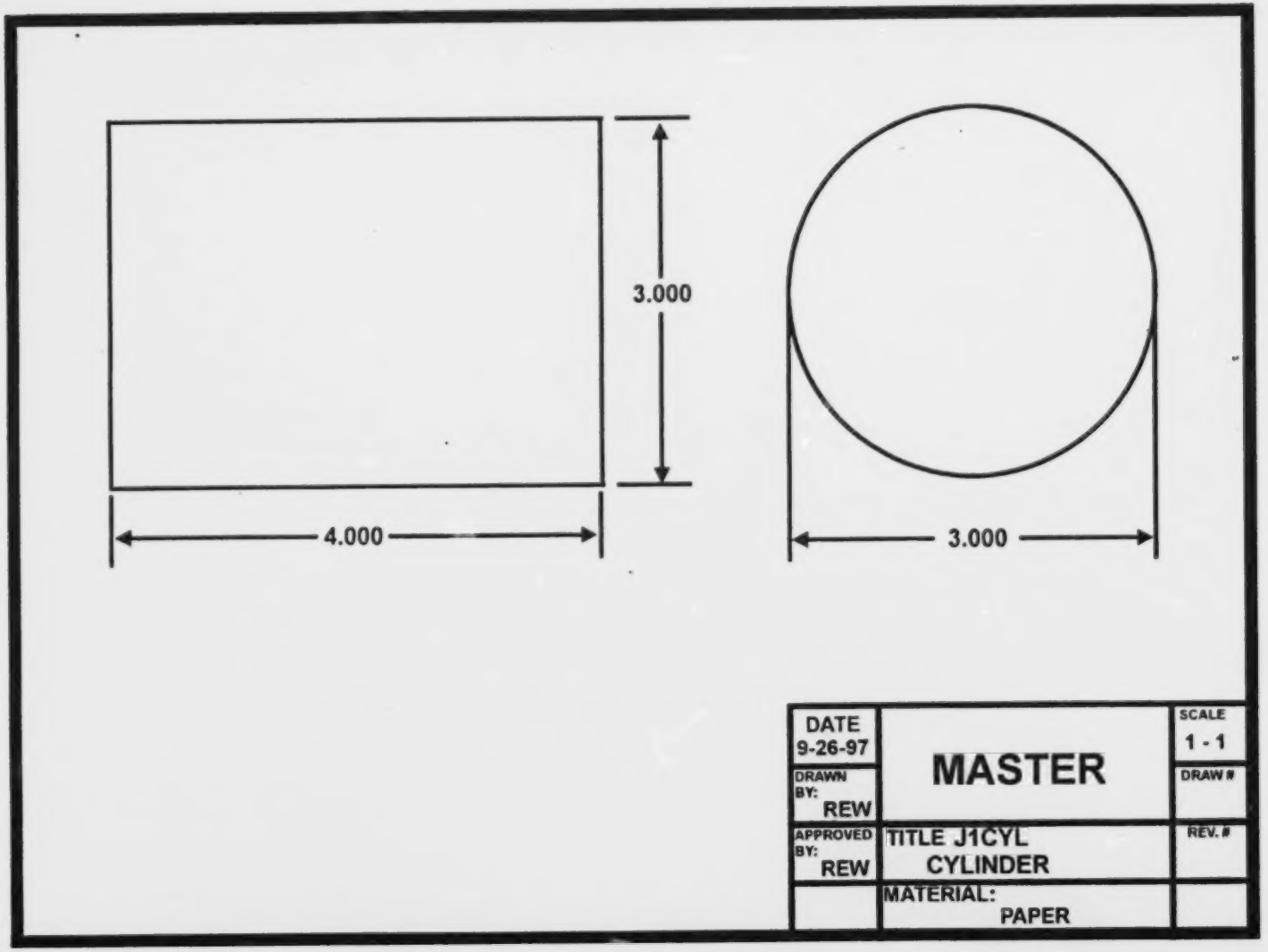
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS
DATE
9-26-97
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
SCALE
1 - 1
DRAW #
TITLE J1PAN
PAN
REV. #
MATERIAL:
PAPER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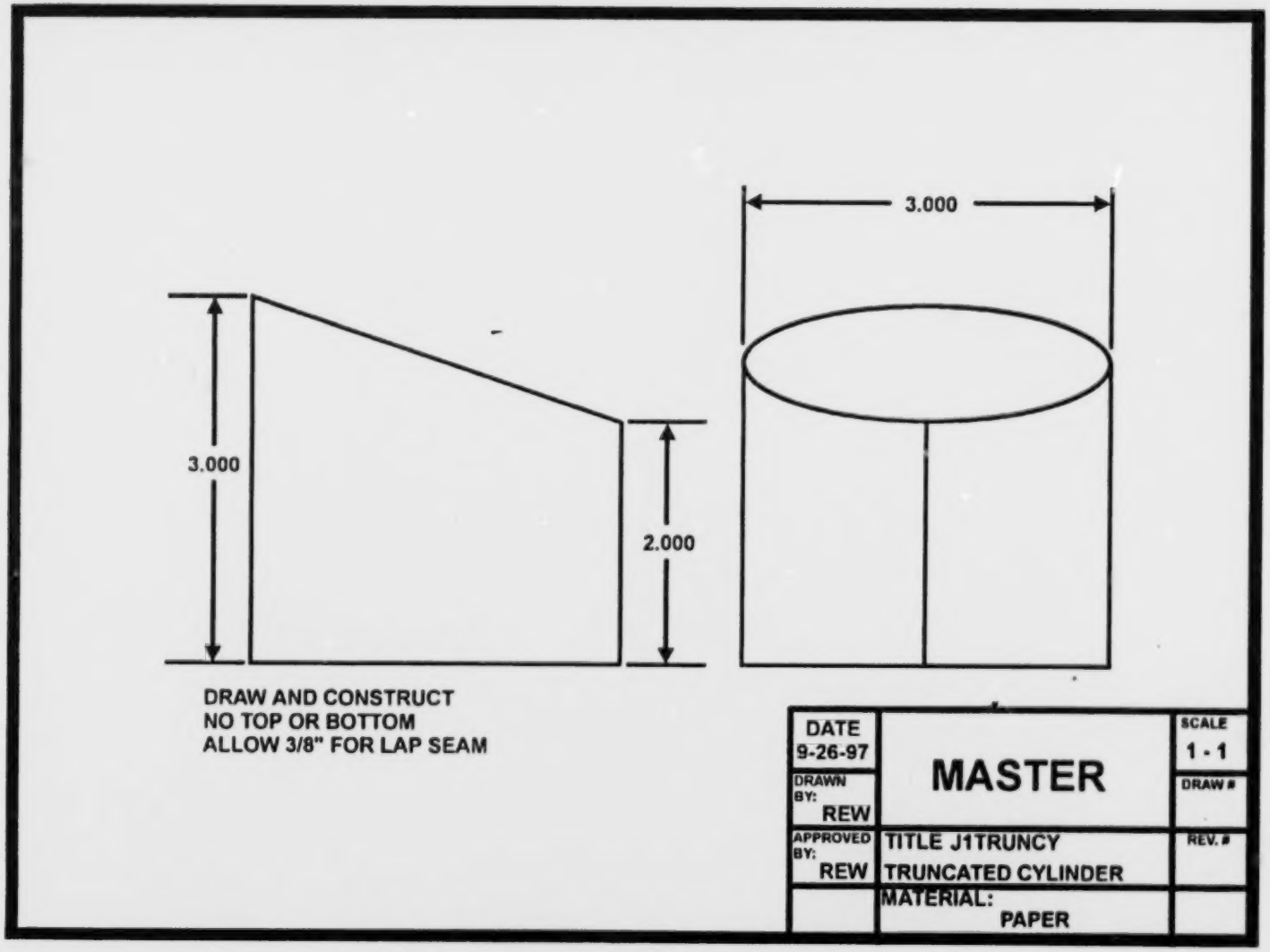
PAPER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DRAW AND CONSTRUCT
NO TOP OR BOTTOM
ALLOW 3/8" FOR LAP SEAM
DATE
9-26-97
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
TITLE J1TRUNCY
TRUNCATED CYLINDER
MATERIAL:
PAPER
SCALE
1 - 1
DRAW #
REV. #

Name:_____ Date:_____

IMM-J1
Layout Sheet Metal Parts
Self-Assessment

Circle the letter preceding the most correct answer.

1. The thickness of sheet metal is _____ inch or less.
   a. 5/8
   b. 1/2
   c. 3/8
   d. 1/8

2. One of the most common materials classified as sheet metal is _____.
   a. Pure lead
   b. Galvanized steel
   c. Pure tin
   d. White cast iron

3. To develop a pattern for a rectangular object is considered _____ development.
   a. Triangulation
   b. Radial Line
   c. Parallel Line
   d. Truncated

4. To develop a pattern for a cone is considered _____ development.
   a. Triangulation
   b. Radial line
   c. Parallel line
   d. Truncated

5. When trying to eliminate sharp edges and provide strength on sheet metal parts a _____ is used.
   a. Hem
   b. Seam
   c. Lap
   d. Flap

6. There are three common sheet metal hems, the single, double and the _____.
   a. Countersunk
   b. Inside
   c. Capsnap
   d. Wire edge

7. When determining the size of the sheet metal for a part the _____ must be considered.
   a. Heat on the part
   b. Bend allowance
   c. Exterior coating
   d. Height of the part

8. Sheet metal and wire diameters are specified by _____.
   a. Gage numbers
   b. Roman numeral
   c. Letters
   d. Common fraction

9. On one side of the wire gage is stamped the _____ and the other side is stamped with the _____.
   a. Fraction, gage number
   b. Letter, fraction
   c. Roman numeral, letter
   d. Gage number, decimal equivalent

IMM-J1
Layout Sheet Metal Parts
Self-Assessment Answer Key

1. d
2. b
3. c
4. b
5. a
6. d
7. b
8. a
9. d

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-J2

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Fabricate/Install Sheet Metal Parts
Task: Form and/or Bend Sheet Metal Parts

Objective(s):

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Instructional Materials:

MASTER Handout (IMM-J2-HO)
MASTER Laboratory Worksheet (IMM-J2-LW)
MASTER Laboratory Aid (IMM-J2-LA)
MASTER Self-Assessment
Tools and materials necessary to complete the projects

References:

Sheet Metal Work (Audel), John D. Bies, Mcmillan Publishing Company, Latest Edition
Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Publishing Company, Latest Edition
Sheet Metalwork, John Nagle, Bergwall Productions, Inc. Garden City, New York, 11530, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J1 "Layout Sheet Metal Parts"

Introduction:

Sheet metal work is a very important part of our every day lives. We find use in our homes in a variety of appliance, heating and air conditioners. We travel to work in cars, busses and air planes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the hand tools and basic machines used to produce sheet metal parts.

Presentation Outline:

I. Identify Sheet Metal Hand Tools
   - A. Layout blue and removers
   - B. Layout tools
   - C. Hammers
   - D. Pliers
   - E. Hand seamers
   - F. Hand groovers

II. Describe Sheet Metal Cutting Tools
   - A. Hand hole punches
   - B. Turret punch
   - C. Tin snips
   - D. Aviation snips
   - E. Double-cutting shear
   - F. Squaring shear
   - G. Notcher
   - H. Ring and circle shear
   - I. Lever shear
   - J. Electric and pneumatic nibblers and sheers

III. Set-up and Operate Sheet Metal Bending Machines
   - A. Bar folder
   - B. Cornice brake
   - C. Press brake
   - D. Box and pan brake

IV. Set-up and Operate Sheet Metal Tools Forming of Cylindrical Parts
   - A. Slip roll forming machine
   - B. Turning machines and wiring machine
   - C. Burring, setting down and double seaming machines
   - D. Crimping and beading machines
   - E. Grooving machines
   - F. Pittsburgh lock forming machines

V. Demonstrate Sheet Metal Hand Bending Stakes
   - A. Bench plate
   - B. Double seaming stake

C. Beakhorn stake
D. Bevel-edge square stake
E. Hatchet stake
F. Needle-case stake
G. Blowhorn stake
H. Hollow mandrel stake

Practical Application:

1. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures.
2. Cut the pan layout to proper size and shape using the proper cutting tools.
3. Bend the pan project using the proper machines and procedures safely.
4. Safely punch or drill the holes using the proper procedures.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J3) dealing with fastening sheet metal parts together.

IMM-J2-HO
Form and/or Bend Sheet Metal Parts
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work Technology and Practice***, Repp/McCarthy, Glencoe/Mcmillian/McGraw-Hill Publishers, Latest Edition:

Chapters	Title
8	Sheet Metal Processing

Module Outline:

I. Identify Sheet Metal Hand Tools
   A. Layout blue and removers
   B. Layout tools
   C. Hammers
   D. Pliers
   E. Hand seamers
   F. Hand groovers

II. Describe Sheet Metal Cutting Tools
   A. Hand hole punches
   B. Turret punch
   C. Tin snips
   D. Aviation snips
   E. Double-cutting shear
   F. Squaring shear
   G. Notcher
   H. Ring and circle shear
   I. Lever shear
   J. Electric and pneumatic nibblers and sheers

III. Set-up and Operate Sheet Metal Bending Machines
   A. Bar folder
   B. Cornice brake
   C. Press brake
   D. Box and pan brake

IV. Set-up and Operate Sheet Metal Tools Forming of Cylindrical Parts
   A. Slip roll forming machine
   B. Turning machines and wiring machine
   C. Burring, setting down and double seaming machines
   D. Crimping and beading machines
   E. Grooving machines
   F. Pittsburgh lock forming machines

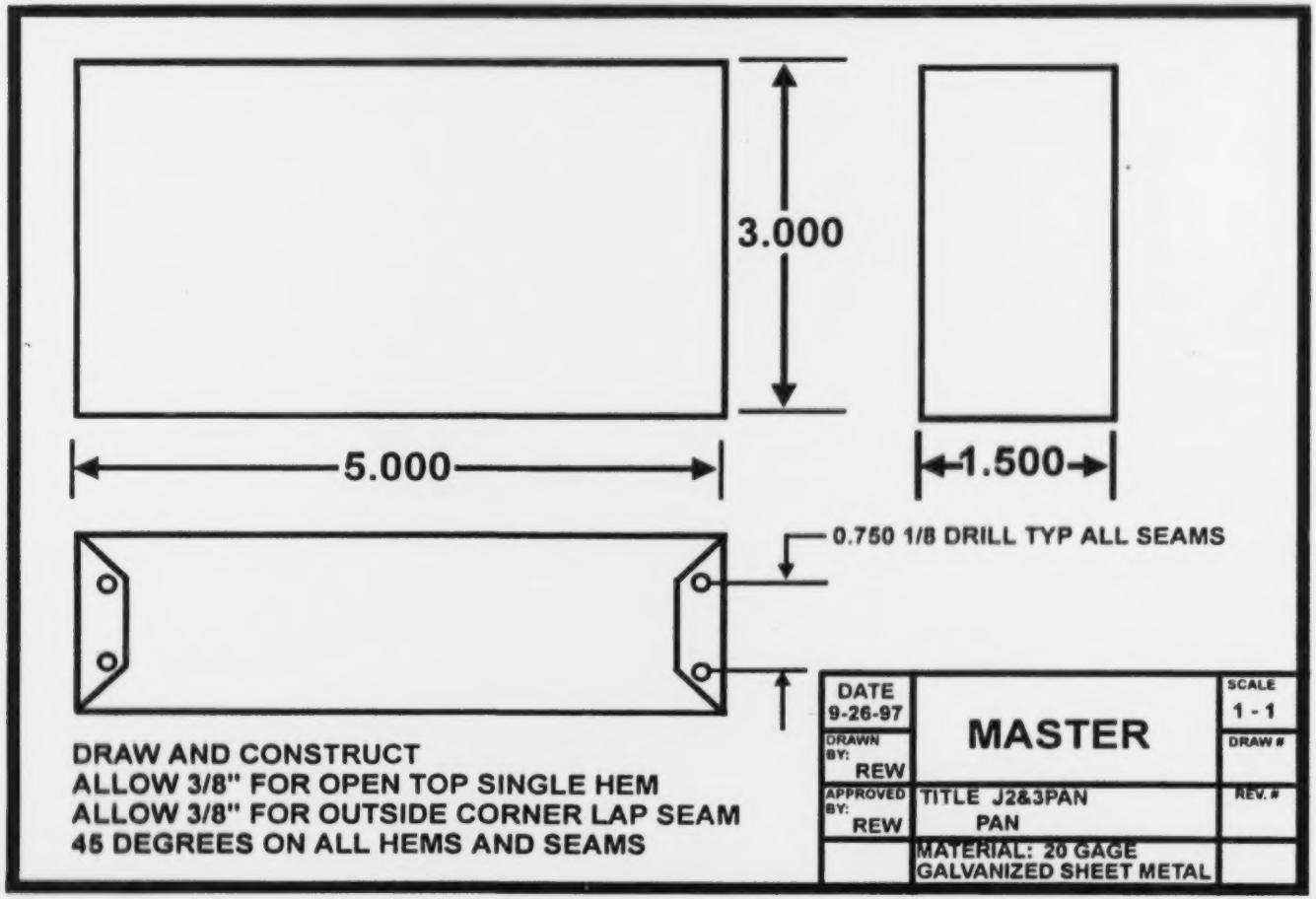
V. Demonstrate Sheet Metal Hand Bending Stakes
   A. Bench plate
   B. Double seaming stake
   C. Beakhorn stake
   D. Bevel-edge square stake
   E. Hatchet stake
   F. Needle-case stake
   G. Blowhorn stake
   H. Hollow mandrel stake

IMM-J2-LA
Form and/or Bend Sheet Metal Parts
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to construct the pan project;
   b. Insure proper tools and materials are available for the pan project;
   c. Proper techniques are used in layout; and,
   d. Proper techniques and safety procedures are followed in construction of the pan project.

2. Student will:
   a. Layout and construct sheet metal pan project;
   b. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures;
   c. Cut the pan layout to proper size and shape using the proper cutting tools;
   d. Bend the pan project using the proper machines and procedures safely; and,
   e. Safely punch or drill the holes using the proper procedures.


3.000
5.000
1.500
0.750 1/8 DRILL TYP ALL SEAMS
DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS
DATE 9-26-97
DRAWN BY: REW
APPROVED BY: REW
MASTER
TITLE J2&3PAN
PAN
MATERIAL: 20 GAGE GALVANIZED SHEET METAL
SCALE 1 - 1
DRAW #
REV. #

Name:_____ Date:_____

IMM-J2
Form and/or Bend Sheet Metal Parts
Self-Assessment

Circle the letter preceding the most correct answer.

1. A tool used in sheet metal layout to produce arcs and circles is called a _____.
   a. Compass
   b. Wing divider
   c. Scratch awl
   d. Inside caliper

2. The hammer used to produce curved parts in sheet metal which can not be produced by a forming machine is a _____ hammer.
   a. Setting
   b. Riveting
   c. Raising
   d. Ball peen

3. After sheet metal is folded and hooked together, _____ should be used to close the seam.
   a. A hand groover
   b. A raising hammer
   c. Flat nose pliers
   d. A center punch

4. The tool used to cut around stove or furnace pipe is _____.
   a. Aviation snips
   b. Tin snips
   c. A double cutting sheer
   d. A hawk's bill scroll snips

5. A hand cutting tool made in right, left and straight blades are _____.
   a. Aviation snips
   b. Tin snips
   c. Double cutting
   d. Hawk's bills

6. If several pieces of sheet metal need to be cut to the same length using the squaring shear the _____ gage may be lock to length.
   a. Wire
   b. Floor
   c. Side
   d. Back

7. If it is necessary to cut small rods the _____ sheer should be used.
   a. Squaring
   b. Notcher
   c. Lever
   d. Ring and circle

8. The bending machine designed to bend seams and hems is the _____.
   a. Press brake
   b. Bar folder
   c. Cornice brake
   d. Box and pan

9. The upper jaw of a _____ brake , is made of several blocks which can be used together or some removed if necessary.
   a. Press brake
   b. Bar folder
   c. Cornice brake
   d. Box and pan brake

10. The forming machine which produces the end on stove and furnace pipes is the _____ machine.
   a. Burring
   b. Slip roll forming
   c. Crimping and beading
   d. Grooving

IMM-J2
Form and/or Bend Sheet Metal Parts
Self-Assessment Answer Sheet:

1. B
2. C
3. A
4. C
5. A
6. D
7. C
8. B
9. D
10. C

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-J3

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Fabricate/Install Sheet Metal Parts
Task: Fasten Sheet Metal Parts Together

Objective(s):

Upon completion of this module the student will be able to:

a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Instructional Materials:

MASTER Handout (IMM-J3-HO)
MASTER Laboratory Worksheet (IMM-J3-LW)
MASTER Laboratory Aid (IMM-J3-LA)
MASTER Self-Assessment
Tools and material necessary to complete the projects

References:

Sheet Metal Work (Audel), John D. Bies, Mcmillan Publishing Company, Latest Edition
Mechanics' and Millwrights' Guide (Audel), Carl A. Nelson, Macmillan Publishing Company, Latest Edition
Sheet Metalwork, John Nagle, Bergwall Productions, Inc. Garden City, New York, 11530, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J2 "Form and/or Bend Sheet Metal Parts"

Introduction:

Sheet metal work is a very important part of our every day lives. We find use in our homes in a variety of appliance, heating and air conditioners. We travel to work in cars, busses and air planes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the ways of fastening sheet metal parts together.

Presentation Outline:

I. Identify Sheet Metal Self Threading Screws
   - A. Thread forming screws
   - B. Thread cutting screws
   - C. Head styles used on threaded fasteners
   - D. Driver recesses used on screw heads
   - E. Drive screw

II. Describe Rivets and Riveting
   - A. Introduction
   - B. Riveting
   - C. Rivet size
   - D. Tinners rivets
   - E. Choosing a rivet
   - F. Rivet spacing
   - G. The rivet set
   - H. How to rivet
   - I. Hot and cold rivets
   - J. Removing rivets
   - K. Tubular and special rivets
   - L. Blind rivets

III. Demonstrate Soldering Sheet Metal
   - A. Introduction to soldering
   - B. Soft soldering
   - C. Heat for soft soldering
   - D. Soldering copper
   - E. Tin a soldering copper
   - F. Preparing the workpiece
   - G. Joints for soft soldering
   - H. Soft soldering techniques
   - I. Hard soldering techniques

IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal
   - A. Introduction
   - B. Difference between brazing and braze welding
   - C. Brazing and braze welding fluxes

D. Rods for brazing and braze welding
E. How to braze with a torch

Practical Application:

1. Secure sheet metal using self threading screws
2. Secure sheet metal using rivets and riveting
3. Secure sheet metal using soldering
4. Secure sheet metal using brazing
5. Secure pan project using pop rivets

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K1) dealing with performing basic pipefitting calculations.

IMM-J3-HO
Fasten Sheet Metal Parts Together
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Reading Assignments:

The following chapters are assigned to read from ***Metal Technology and Practice***, Repp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

Chapters	Title
7	Fitting and Assembling

Module Outline:

I. Identify Sheet Metal Self Threading Screws
   A. Thread forming screws
   B. Thread cutting screws
   C. Head styles used on threaded fasteners
   D. Driver recesses used on screw heads
   E. Drive screw
II. Describe Rivets and Riveting
   A. Introduction
   B. Riveting

C. Rivet size
D. Tinners rivets
E. Choosing a rivet
F. Rivet spacing
G. The rivet set
H. How to rivet
I. Hot and cold rivets
J. Removing rivets
K. Tubular and special rivets
L. Blind rivets

III. Demonstrate Soldering Sheet Metal
A. Introduction to soldering
B. Soft soldering
C. Heat for soft soldering
D. Soldering copper
E. Tin a soldering copper
F. Preparing the workpiece
G. Joints for soft soldering
H. Soft soldering techniques
I. Hard soldering techniques

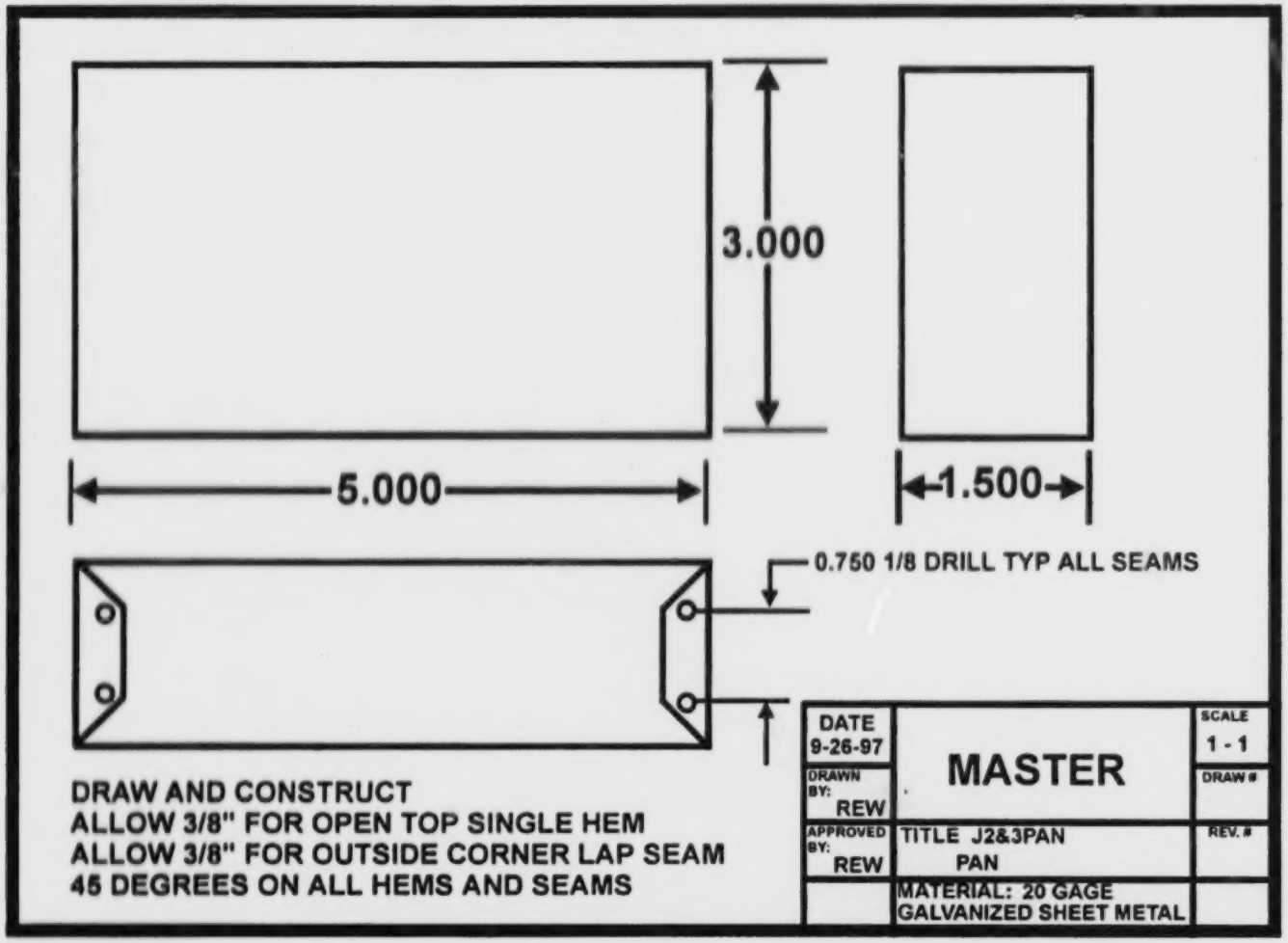
IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal
A. Introduction
B. Difference between brazing and braze welding
C. Brazing and braze welding fluxes
D. Rods for brazing and braze welding
E. How to braze with a torch

IMM-J3-LA
Fasten Sheet Metal Parts Together
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to assemble sheet metal parts;
   b. Insure proper tools and materials are available for projects; and,
   c. Proper techniques and safety procedures are followed in constructing projects.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the projects;
   b. Secure sheet metal using self threading screws;
   c. Secure sheet metal using rivets and riveting;
   d. Secure sheet metal using soldering;
   e. Secure sheet metal using brazing; and,
   f. Secure pan project using pop rivets.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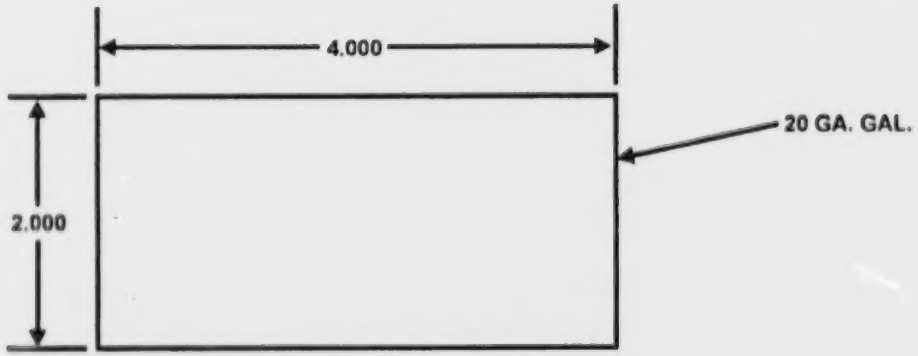
SCALE 1 - 1
DRAW #
REV. #



ASSEMBLE 2 EA. WITH SELF THREADING SCREWS
ASSEMBLE 2 EA. WITH RIVETS
ASSEMBLE 2 EA. BY SOLDERING
ASSEMBLE 2 EA. BY BRAZING

DATE 9-26-97	MASTER	SCALE 1 - 1
DRAWN BY: REW		DRAW #
APPROVED BY: REW	TITLE J3THRIV THREAD AND RIVET PLT.	REV. #
	MATERIAL: 20 GAGE GALVANIZED SHEET METAL	

Name:_____ Date:_____

IMM-J3
Fasten Sheet Metal Parts Together
Self-Assessment

Circle the letter preceding the most correct answer:

1. The drill size to use for self threading screw is _____.
   a. 1/8" diameter
   b. 1/16 smaller than the minor diameter of the screw
   c. Slightly larger than the minor diameter of the screw
   d. The same size as the major diameter of the screw

2. Another name for blind rivets is _____.
   a. Solid
   b. Pop
   c. Tubular
   d. Tinners

3. Tinners rivets for sheet metal are supplied in sizes determined by their _____.
   a. Material
   b. Diameter
   c. Length
   d. Weight per 1000

4. The rivet should be _____ in diameter than the holes in the pieces to be riveted.
   a. .003" to .016" larger
   b. .003" to .016" smaller
   c. .016" to .032" larger
   d. .016 to .032" smaller

5. A plier like hand tool is used for clinching _____ rivets.
   a. Tubular
   b. Blind
   c. Solid
   d. Tinners

6. When soldering sheet metal if the solder melts below 800°F the process is called _____.
   a. Hard soldering
   b. Brazing
   c. Soft soldering
   d. Fusion

7. For general work when soft soldering a solder of one half lead and one half _____ is used.
   a. Silver
   b. Steel
   c. Bronze
   d. Tin

8. The flux used in soldering is used to remove the _____ from the material being soldered.
   a. Oxide
   b. Carbon
   c. Rust
   d. Grease

9. When brazing the filler metal melts and flows into the joint by _____.
   a. Fusion
   b. Forming a bead
   c. Capillary action
   d. Like arc welding

10. The main two metals used in brazing rods are copper and _____.
   a. Tin
   b. Lead
   c. Iron
   d. Zinc

IMM-J3
Fasten Sheet Metal Parts Together
Self-Assessment Answer Key

1. C
2. B
3. B
4. B
5. B
6. C
7. D
8. A
9. C
10. D

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Trouble-shoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K1

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Piping Operations
Task: Perform Basic Pipefitting Calculations

Objective(s):

Upon completion of this module the student will be able to:

a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Instructional Materials:

MASTER Handout (IMM-K1-HO)
MASTER Self-Assessment
Assorted of threaded and socket weld fittings
6' carpenters folding ruler
Pipe fitters hand books
Framing square

References:

Pipe Fitters and Pipe Welders Handbook, Thomas Frankland, Glencoe Publishing Co., Latest Edition
Mathematics for Plumbers and Pipefitters, Arcangelo, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J3 "Fasten Sheet Metal Parts Together"

Introduction:

Pipes need to be of exact lengths and exactly placed. Accurately performing piping calculations is necessary to fabricate the pipe to fit correctly.

Presentation Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   - A. Run
   - B. Set
   - C. Travel
   - D. Offset

II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
   - A. Obstructions to be worked around
     1. Other pipe
     2. Wall
     3. Equipment

III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter
   - A. Center line measurements. (point to point)
   - B. Simple offset
     1. Using table of multipliers for calculating simple offsets
     2. Discuss the concept that an offset is nothing more than the missing side of a right triangle
   - C. Equal spread offset
     1. Two-pipe spread using 22-1/2 degree threaded fittings
     2. Review formula and tables from pipe fitting hand book
   - D. Rolling offset
     1. Use of trigonometric tables in calculation of rolling offset
     2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"

Practical Application:

The student will:

1. Identify terms frequently used in pipe fitting formulas.
   - A. Run
   - B. Set
   - C. Travel
   - D. Offset
2. Identify conditions that will require the use of pipe fitting formulas.

A. Obstructions to be worked around.
   1. Other pipe
   2. Wall
   3. Equipment

3. Identify and demonstrate various calculations and measurements required of a pipe fitter.
   A. Center line measurements. (point to point)
   B. Simple offset
      1. Using table of multipliers for calculating simple offsets.
      2. Discuss the concept that an offset is nothing more than the missing side of a right triangle.
   C. Equal spread offset.
      1. Two pipe spread using 22-1/2 degree screwed fittings.
      2. Review formula and tables from pipe fitting hand book.
   D. Rolling offset.
      1. Use of trigonometric tables in calculation of rolling offset.
      2. Demonstrate simplified method of finding a rolling offset using a framing square.
4. Demonstrate how to lay out on paper a piping system consisting of horizontal runs, vertical runs and a simple rolling offset to a tolerance of 1/8".

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Self-Assessment.

Summary:

Review the main lesson points using the objectives as a guide to discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K2) dealing with cutting, threading, and reaming pipe.

IMM-K1-HO
Perform Basic Pipefitting Calculations
Attachment 1: **MASTER** Handout

Standards of performance:

Student will demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Reading Assignments:

The following chapters are assigned to read from ***Millwright's Handbook***, Audel Publishers, Latest Edition:

Chapters	Title
14	Fittings

Module Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   A. Run
   B. Set
   C. Travel
   D. Offset
II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
   A. Obstructions to be worked around

1. Other pipe
2. Wall
3. Equipment

III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter
   A. Center line measurements. (point to point)
   B. Simple offset
      1. Using table of multipliers for calculating simple offsets
      2. Discuss the concept that an offset is nothing more than the missing side of a right triangle
   C. Equal spread offset
      1. Two-pipe spread using 22-1/2 degree threaded fittings
      2. Review formula and tables from pipe fitting hand book
   D. Rolling offset
      1. Use of trigonometric tables in calculation of rolling offset
      2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"

Name:_____ Date:_____

IMM-K1
Perform Basic Pipefitting Calculations
Self-Assessment

1. Define run.

2. Define offset.

3. Define travel.

4. Define right triangle.

5. Define rolling offset.

6. List steps to perform equal spread offsets.

IMM-K1
Perform Basic Pipefitting Calculations
Self-Assessment Answer Key

1. Length of conduit

2. Raising or lowering the line of the conduit or alignment. This is accomplished by bending the line at a 45°angle and at the depth of offset placing another 45° angle in the opposite direction to the first angle.

3. Distance moves on a horizontal plane

4. A 3 sided figure. One of the three angles is 90°

5. Pipe that is offset has parallel lines sepaarated by two 45° angles

6. Make 45° bend. Move bender to length fo offset. Make second 45° bend oposite first 45° bend.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K2

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Piping Operations
Task: Cut, Thread, and Ream Pipe

Objective(s):

Upon completion of this module the student will be able to:

a. Identify two methods of cutting reaming and threading pipe;
b. Identify equipment required to cut thread and ream pipe;
c. Describe the use and care of equipment required when cutting, threading and reaming pipe;
d. Identify safety concerns that apply to use of cutting, threading and reaming equipment; and,
e. Fabricate from pipe stock, using a NPT threaded nipple that is cut square and properly reamed.

Instructional Materials:

MASTER Handout (IMM-K2-HO)
MASTER Laboratory Worksheet (IMM-K2-LW)
MASTER Laboratory Aid (IMM-K2-LA)
MASTER Self-Assessment
Hand pipe reamer
Set of hand operated pipe dies
Pipe vice
Electric pipe threading, cutting and reaming equipment
6' Folding ruler
Cutting fluid
Assorted sections of metal pipe

References:

Pipe Fitters and Pipe Welders Handbook, Thomas Frankland, Glenco Publishing Co., Latest Edition
Mathematics for Plumbers and Pipefitters, Arcangelo, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K1 "Perform Basic Pipefitting Calculations"

Introduction:

Pipe need to be placed in exact locations. Therefore, pipe must be cut, threaded and reamed. Reaming removes burrs so materials can go through the pipe unobstructed. Threading allows pipes to be joined.

Presentation Outline:

I. Identify Two Methods of Cutting, Reaming and Threading Pipe
   A. Hand operated
   B. Electric
II. Identify Equipment Required to Cut Thread and Ream Pipe
   A. Hand pipe reamer
   B. Hand or electric
   C. Set of hand operated pipe dies
   D. Pipe vice
   E. Electric pipe threading, cutting and reaming equipment
   F. Folding ruler
   G. Cutting fluid
   H. Describe the use and care of equipment required when cutting, threading and reaming pipe.
III. Identify Safety Concerns That Apply to Use of Cutting, Threading and Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles
IV. Demonstrate How to Fabricate from Pipe Stock, Using a NPT Threaded Nipple That Is Cut Square and Properly Reamed

Practical Application:

I. Identify safety concerns that apply to use of cutting, threading and reaming equipment;
   A. High torque rotating equipment;
   B. Sharp edges and metal shavings;
   C. Sharp tools;
   D. Flying particles;

II. Practice hand cutting, reaming and threading pipe;
III. Practice using the electric pipe cutting, threading and reaming equipment; and,
IV. Practice fabricating from pipe stock, using a NPT threaded nipple that is cut, square and properly reamed.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K3) dealing with pipe assembly.

IMM-K2-HO
Cut, Thread, and Ream Pipe
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify two methods of cutting, reaming and threading pipe;
b. Identify equipment required to cut, thread and ream pipe;
c. Describe the use and care of equipment required when cutting, threading and reaming pipe;
d. Identify safety concerns that apply to use of cutting, threading and reaming equipment; and,
e. Fabricate from pipe stock, a NPT threaded nipple that is cut, square and properly reamed.

Module Outline:

I. Identify Safety Concerns That Apply to Use of Cutting, Threading and Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles
II. Practice Hand Cutting, Reaming and Threading Pipe
III. Practice Using the Electric Pipe Cutting, Threading and Reaming Equipment
IV. Practice Fabricating from Pipe Stock, Using a NPT Threaded Nipple That Is Cut Square and Properly Reamed

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-K2-LW
Cut, Thread, and Ream Pipe
Attachment 3: **MASTER** Laboratory Worksheet

Practice:

1. Identifying methods of cutting, reaming and threading pipe.

   _____

   _____

2. Identify equipment required to cut thread and ream pipe.

   _____

   _____

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

   _____

   _____

4. Demonstrate how to fabricate from pipe stock.

   _____

   _____

5. Demonstrate how a NPT threaded nipple is cut.

   _____

   _____

6. Demonstrate how to square and properly ream a NPT threaded nipple.

_____

_____

Instructor will use the following to generate a practical exam:

1. Identify two methods of cutting, reaming and threading pipe.

_____

_____

2. Identify equipment required to cut thread and ream pipe.

_____

_____

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

_____

_____

4. Demonstrate how to fabricate from pipe stock, a NPT threaded nipple that is cut square and properly reamed.

_____

_____

Name:_____ Date:_____

IMM-K2
Cut, Thread, and Ream Pipe
Self-Assessment

1. **Identify two methods of cutting, reaming and threading pipe.**

   _____
   _____
   _____

2. **Identify equipment required to cut, thread and ream pipe.**

   _____
   _____
   _____

3. **Describe the use and care of equipment required when cutting, threading and reaming pipe.**

   _____
   _____
   _____

4. **Identify safety concerns that apply to use of cutting, threading and reaming equipment.**

   _____
   _____
   _____

5. **Discuss how to fabricate from pipe stock, using a NPT threaded nipple that is cut square and properly reamed.**

   _____
   _____
   _____

IMM-K2
Cut, Thread, and Ream Pipe
Self-Assessment Answer Key

1. Manual with hand tools or using power operated equipment.

2. Pipe cutter, pipe threader, and pipe reamer

3. Cutting, threading and reaming creates sharp edges and hot surfaces. Make sure equipment is clean and well lubricated to reduce heat and friction.

4. Cutting, threading and reaming creates sharp edges and hot surfaces. Be careful not to cut or burn oneself due to this activity.

5. A threaded nipple can be screwed into a pipe coupling or male fitting.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K3

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Piping Operations
Task: Pipe Assembly

Objective(s):

Upon completion of this module the student will be able to:

a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Instructional Materials:

MASTER Handout (IMM-K3-HO)
MASTER Laboratory Worksheet (IMM-K3-LW)
MASTER Laboratory Aid (IMM-K3-LA)
MASTER Self-Assessment
Pipe Vice
Ruler
Cutting Fluid
Sections of Threaded Metal Pipe
Pipe Wrenches
Pipe Compound
Nut, bolts, and washers appropriate for the flange in use
Gasket suitable for the flange in use

References:

Plumbing Installation and Design, James A. Sullivan, Latest Edition
Plumber's and Pipe Fitter's Handbook, Williams and Hornung, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-K2 "Cut, Thread, and Ream Pipe"

Introduction:

In order to maintain rigidity and withstand a harsh environment, pipes and flanges must be threaded.

Presentation Outline:

I. Identify Two Types of Threaded Companion Flanges
   - A. Standard
   - B. Heavy

II. Identify Typical Materials from Which Threaded Flanges Are Made
   - A. Iron
   - B. Cast Iron
   - C. Stainless Steel
   - D. Various types of plastic

III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
   - A. Apply pipe compound appropriate for the system to the pipe threads
   - B. Install first flange half snug but not tight
   - C. Install last flange half snug
   - D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
   - A. Sharp threads
   - B. Heavy components in awkward positions
   - C. Heavy gloves
   - D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   - A. Explain why a pipe should not be over threaded
   - B. Correct amount of compound
   - C. Correct assembly technique
   - D. Gasket type and position

Practical Application:

1. Point out safety concerns that apply to assembling a threaded flange.
   - A. Sharp threads
   - B. Heavy components in awkward positions
   - C. Heavy gloves

D, Safety glasses with side shields

2. Practice assembling a threaded flange connection.
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket positioning

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K4) dealing with installing and adjusting pipe support.

IMM-K3-HO
Pipe Assembly
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Reading Assignments:

The following chapters are assigned to read from ***Millwrights' Handbook***, Audel Publishers, Latest Edition:.

Chapters	**Title**
14	Fittings

Module Outline:

I. Identify Two Types of Threaded Companion Flanges
   A. Standard
   B. Heavy
II. Identify Typical Materials from Which Threaded Flanges Are Made
   A. Iron
   B. Cast Iron
   C. Stainless Steel
   D. Various types of plastic

III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
   A. Apply pipe compound appropriate for the system to the pipe threads
   B. Install first flange half snug but not tight
   C. Install last flange half snug
   D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
   A. Sharp threads
   B. Heavy components in awkward positions
   C. Heavy gloves
   D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket type and position

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-K3-LW
Pipe Assembly
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Practice identifying types of threaded companies flanges.
2. List materials that threaded flanges are made up of.
3. List steps to assemble threaded flanges.
4. Assemble a threaded flange.
5. List safety concerns when assembling a threaded flange.

Name:_____ Date:_____

IMM-K3
Pipe Assembly
Self-Assessment

1. List two common materials used in threaded flanges.

_____
_____
_____

2. List steps to assemble threaded flanges.

_____
_____
_____

3. List two safety concerns when assembling a threaded flange.

_____
_____
_____

4. List two ways to join threaded flanges.

_____
_____
_____

5. Explain purpose of cutting fluid.

_____
_____
_____

IMM-K3
Pipe Assembly
Self-Assessment Answer Key

1. **Forged or cast pipe.**

2. **Clean parts, proper alignment, proper support, proper gasket insertion, proper tightening of bolts.**

3. **Eye and hand protection.**

4. **Flanges are joined by welding or being bolted together.**

5. **Cutting fluid serves to lubricate and reduce friction, therefore, reducing heat.**

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K4

Subject: Industrial Maintenance **Time:** 3 Hrs.

Duty: Piping Operations
Task: Install and Adjust Pipe Support

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of pipes supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Instructional Materials:

MASTER Handout (IMM-K4-HO)
MASTER Laboratory Aid (IMM-K4-LA)
MASTER Laboratory Worksheet (IMM-K4-LW)
MASTER Self-Assessment

References:

Piping Systems, Mechanical Equipment Series 736, Schoolcraft Publishing, Latest Edition
Video: ***Plumbing and Pipe Fitting,*** 730 Bergwall, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition
Tube Fittings, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K3 "Pipe Assembly"

Introduction:

Piping systems are a very essential part of our lives. Industrial plants have miles of pipe lines to carry their products, gases or fluids necessary for producing the product.

Construction and many other pieces of equipment rely on hydraulic flow to complete their operations. Even our homes need water lines and piping for appliances, heating and cooling systems for our comfort and health. This section pertains to the way pipe lines must be supported for proper material flow.

Presentation Outline:

I. Describe the Purpose of Pipe Supports
   - A. Position
   - B. Materials the support may be attached to
   - C. Reasons for pipe supports

II. Identify the Types of Pipe Supports
   - A. Reznor hook
   - B. Pipe strap
   - C. Perforated iron strap
   - D. Clevis hanger
   - E. F&M hanger
   - F. Coil hanger
   - G. Spring cushion
   - H. Special hangers
   - I. Split ring hanger

III. Describe the Distance Between Hangers
   - A. Type of pipe
   - B. Type of joints

IV. Identify the Pipe Support Fastener
   - A. Fastening to different materials
   - B. The type and procedure for each fastener

Practical Application:

1. Support the side of the piping project to a vertical wood 2x4 using proper hardware.
2. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K5) dealing with tubing.

IMM-K4-HO
Install and Adjust Pipe Support
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of pipe supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Reading Assignments:

The following chapters are assigned to read from ***Basic Plumbing***, Harry Slater & Lee Smith, Delmar Publishers, Latest Edition:

Section	Unit
5-Plumbing Hardware	28-Pipe Hangers
5-Plumbing Hardware	29-Fastenings

Module Outline:

I. Describe the Purpose of Pipe Supports
   A. Position
   B. Materials the support may be attached to
   C. Reasons for pipe supports
II. Identify the Types of Pipe Supports
   A. Reznor hook
   B. Pipe strap
   C. Perforated iron strap
   D. Clevis hanger

E. F&M hanger
F. Coil hanger
G. Spring cushion
H. Special hangers
I. Split ring hanger

III. Describe the Distance Between Hangers
A. Type of pipe
B. Type of joints

IV. Identify the Pipe Support Fastener
A. Fastening to different materials
B. The type and procedure for each fastener

IMM-K4-LA
Install and Adjust Pipe Support
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Support the side of the piping project to a vertical wood 2x4 using proper hardware; and,
   c. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.

IMM-K4-LW
Install and Adjust Pipe Support
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

2. Student will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

3. Instructor will grade student's ability to:
   a. Install pipe supports; and,
   b. Adjust pipe supports.

Name:_____ Date:_____

IMM-K4
Install and Adjust Pipe Support
Self-Assessment

Circle the letter preceding the most correct answer.

1. The first consideration of selecting a pipe hanger would be the weight of the pipe and its _____.
   a. Direction of flow
   b. Content weight
   c. Number of joints
   d. Number of tees

2. The _____ of the material in the pipe could affect the hanger selection due to expansion and contraction.
   a. Thickness
   b. Weight
   c. Temperature
   d. Color

3. The hanger that is made of wire which is bent, pointed and is driven in wood is the _____.
   a. Reznor hook
   b. Clevis hanger
   c. F&M hanger
   d. Pipe strap

4. The hanger used on walls or ceilings to support small pipe is the _____.
   a. Reznor hook
   b. Clevis hanger
   c. F&M hanger
   d. Pipe strap

5. The pipe strap should be fastened to a wood structure by using _____.
   a. #16 nails
   b. #8 nails
   c. Round head screws
   d. Hex head screws

6. The hanger used for large pipe where the top half may be installed first because the bottom half is removable is the _____.
   a. Coil hanger
   b. Reznor hook
   c. F&M hanger
   d. Clevis hanger

7. Rigid steel, brass, or copper should have a support about every _____ feet apart.
   a. 5-10
   b. 15-20
   c. 20-25
   d. 25-30

8. When securing a clevis hanger to a wood joist a/an _____ is used.
   a. U-bolt
   b. Hanger bolt
   c. Hex head machine screw
   d. Allen head cap screw

9. A general rule for horizontal pipe supports allow the pipe to hang _____ inches.
   a. 6-12
   b. 12-24
   c. 24-30
   d. 24-36

10. To secure hangers to concrete, stone, or brick, a hole may be drilled using a _____ tipped masonry bit.
   a. Mild steel
   b. Carbon steel
   c. High speed steel
   d. Carbide

IMM-K-4
Install and Adjust Pipe Support
Self-Assessment Answer Key

1. B
2. C
3. A
4. D
5. C
6. D
7. A
8. B
9. B
10. D

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K5

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Piping Operations
Task: Tubing

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Instructional Materials:

MASTER Handout (IMM-K5-HO)
MASTER Laboratory Aid (IMM-K5-LA)
MASTER Laboratory Worksheet (IMM-K5-LW)
MASTER Self-Assessment
3/4 Black Steel Pipe
1/2 Hard Copper
1/4 Soft Copper Tubing
1/2 CPVC Plastic Pipe
Ample Elbows
Tees
Reducers
Flare & Ferrel Tubing
Fittings
Couplings
Unions
Also enough flux, solder, plastic pipe solvent to complete the pipe project

References:

Basic Plumbing, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition
Video: ***Plumbing and Pipefitting 730***, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition

Tube Fittings, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K4 "Install and Adjust Pipe Support"

Introduction:

Tubing is used in many applications from hydraulics to refrigeration, from industrial to residential, and everywhere in between. It is essential that tubing, of all types, be understood.

Presentation Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing
II. Demonstrate How to Join Tubing
   A. Cutting
   B. Deburring
   C. Soldering
   E. Flared and ferrule fittings
   E. Bending
III. Identify Types of Tubing
   A. Copper
   B. Steel
   C. Aluminum
   D. Plastic
   E. Other applications
IV. Describe Tubing Maintenance
   A. Check system
   B. Repair system

Practical Application:

1. Cut type M rigid copper tubing.
2. Deburr solder proper fittings to type M rigid 1/2 inch copper tubing.
3. Bend, cut, and debur 1/4 inch soft copper tubing.
4. Flare one end and use a ferrule on the tee end of 1/4 inch soft copper tubing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K6) dealing with fittings.

IMM-K5-HO
Tubing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL 60089, 1-800-837-1255, Latest Edition:

Chapter	Title
4	Tubing

Module Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing
II. Demonstrate How to Join Tubing
   A. Cutting
   B. Deburring
   C. Soldering
   E. Flared and ferrule fittings
   E. Bending

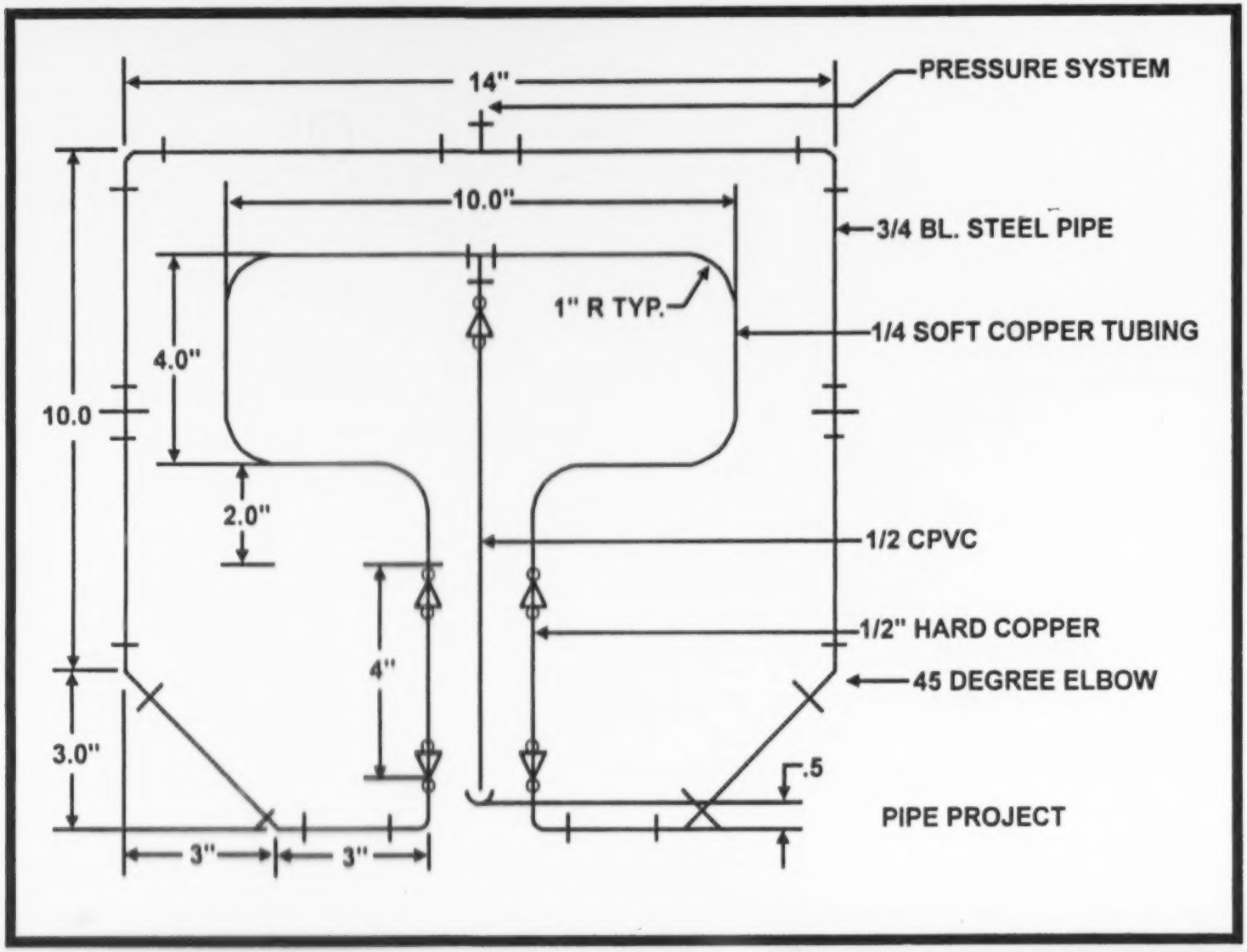
III. Identify Types of Tubing
    A. Copper
    B. Steel
    C. Aluminum
    D. Plastic
    E. Other applications
IV. Describe Tubing Maintenance
    A. Check system
    B. Repair system

IMM-K5-LA
Tubing
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Cut type M rigid copper tubing;
   c. Debur solder proper fittings to type M rigid 1/2 inch copper tubing;
   d. Bend, cut, and debur 1/4 inch soft copper tubing; and,
   e. Flair one end and use a ferrule on the tee end of 1/4 inch soft copper tubing.


14"
PRESSURE SYSTEM
10.0"
3/4 BL. STEEL PIPE
1" R TYP.
1/4 SOFT COPPER TUBING
4.0"
10.0
2.0"
1/2 CPVC
1/2" HARD COPPER
4"
45 DEGREE ELBOW
3.0"
.5
PIPE PROJECT
3"
3"

743

Name:_____ Date:_____

IMM-K5
Tubing
Self-Assessment

Circle the letter preceding the most correct answer.

1. Tubing wall thickness is measured in _____.
   a. Fraction of an inch
   b. Decimal of an inch
   c. Fraction of a foot
   d. Decimal of a foot

2. Metallic tubing is made from _____.
   a. Steel, lead, and aluminum
   b. Copper, stainless steel, tin, and steel
   c. Steel, copper, stainless steel, and aluminum
   d. Iron, copper, steel, and aluminum

3. When pressure may reach 6000 pounds the tubing is made of _____.
   a. Copper
   b. Stainless steel
   c. Aluminum
   d. Plastic

4. One reason the wall thickness of tubing is thinner than pipe is because of the _____.
   a. Length of the pipe
   b. Length of the tubing
   c. Coating applied to tubing
   d. Way it is joined

5. If a fluid system must be installed in a confined area with several directional changes, _____ would be recommended for the system.
   a. Tubing
   b. Wrought iron
   c. Cast iron
   d. Steel pipe

6. If a water system requires an on-off flow, tubing would be used because it _____.
   a. Wall thickness is stronger
   b. Uses threaded fittings
   c. Is more giving
   d. Comes in longer lengths

7. Tubing cutters will cut tubing square because of the _____ rollers on the opposite side of the cutting wheel.
   a. 5
   b. 4
   c. 3
   d. 2

8. When soldering tubing it must be cleaned with emery cloth or wire brush and chemically cleaned with _____.
   a. Soap and water
   b. Solvent
   c. Flux
   d. Oil

9. When tubing is bent in a conical shape on the end to be joined to a fitting, _____ must be used.
   a. A flaring tool
   b. A plumbob
   c. A hacksaw
   d. Slip joint pliers

10. A flaireless fitting used in connecting tubing uses _____ to prevent the tubing fitting from leaking.
   a. Pipe dope
   b. Teflon
   c. Duct tape
   d. A ferrule

11. To make tubing soft so it may be flared or bent without cracking, it is put through a process called _____.
   a. Annealing
   b. Heat treatment
   c. Soldering
   d. Salting

12. Copper tubing used in general plumbing and heating applications with a medium wall thickness is type _____.
    a. K
    b. L
    c. M
    d. N

13. Small diameter tubing may be bent with hand benders while large diameter tubing must be bent with _____.
    a. Ball peen hammer
    b. Hydraulic benders
    c. Pipe wrenches
    d. A round pipe

IMM-K5
Tubing
Self-Assessment Answer Key

1. B
2. C
3. B
4. D
5. A
6. C
7. D
8. C
9. A
10. D
11. A
12. C
13. B

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K6

Subject: Industrial Maintenance **Time:** 8 Hrs.

Duty: Piping Operations
Task: Fittings

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Instructional Materials:

MASTER Handout (IMM-K6-HO)
MASTER Laboratory Aid (IMM-K6-LA)
MASTER Laboratory Worksheet (IMM-K6-LW)
MASTER Self-Assessment
3/4 Black Steel Pipe
1/2 Hard Copper
1/4 Soft Copper Tubing
1/2 CPVC Plastic Pipe
Ample Elbows
Tees
Reducers
Flare & Ferrel Tubing
Fittings
Couplings
Unions
Also enough flux, solder, plastic pipe solvent to complete the pipe project.

References:

Basic Plumbing, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition
Video: *Plumbing and Pipefitting 730*, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition

Tube Fittings, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K5 "Tubing"

Introduction:

There are miles and miles of pipe and tubing lines throughout this world providing us with goods and services. In industry, for the products to be manufactured, it requires piping systems to insure quality and safety. Our homes have many systems, such as water, both hot and cold, sewerage and drain lines; even the refrigerators and air conditioners have many tubing and piping systems. This section deals with the fitting that put these and other systems together.

Presentation Outline:

I. Describe the Purpose of Fittings
   - A. Connect sections
   - B. Change the flow
   - C. Pipe and tubing

II. Identify the Function of Fittings
   - A. Change the direction of flow
   - B. Providing branch connections
   - C. Change line size
   - D. Caps, plugs and couplings

III. Demonstrate How Fittings Are Connected
   - A. Screwed
   - B. Flanged
   - C. Welded
   - D. Tubing

IV. Identify Drawing Symbols
   - A. Flanged
   - B. Screwed
   - C. Welded
   - D. Bell and spigot
   - E. Soldered

Practical Application:

1. Join pipe in piping project.

2. Join copper tubing by soldering in piping project.
3. Join copper tubing with fittings, ferrule and flare in piping project.
4. Join plastic tubing in piping project.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K7) dealing with plastic pipe.

IMM-K6-HO
Fittings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL. 60089, 1-800-837-1255, Latest Edition:

Chapter	Title
6	Fittings

Module Outline:

I. Describe the Purpose of Fittings
   A. Connect sections
   B. Change the flow
   C. Pipe and tubing
II. Identify the Function of Fittings
   A. Change the direction of flow
   B. Providing branch connections
   C. Change line size
   D. Caps, plugs and couplings

III. Demonstrate How Fittings Are Connected
   A. Screwed
   B. Flanged
   C. Welded
   D. Tubing
IV. Identify Drawing Symbols
   A. Flanged
   B. Screwed
   C. Welded
   D. Bell and spigot
   E. Soldered

IMM-K6-LA
Fittings
Attachment 2: **MASTER** Laboratory Aid

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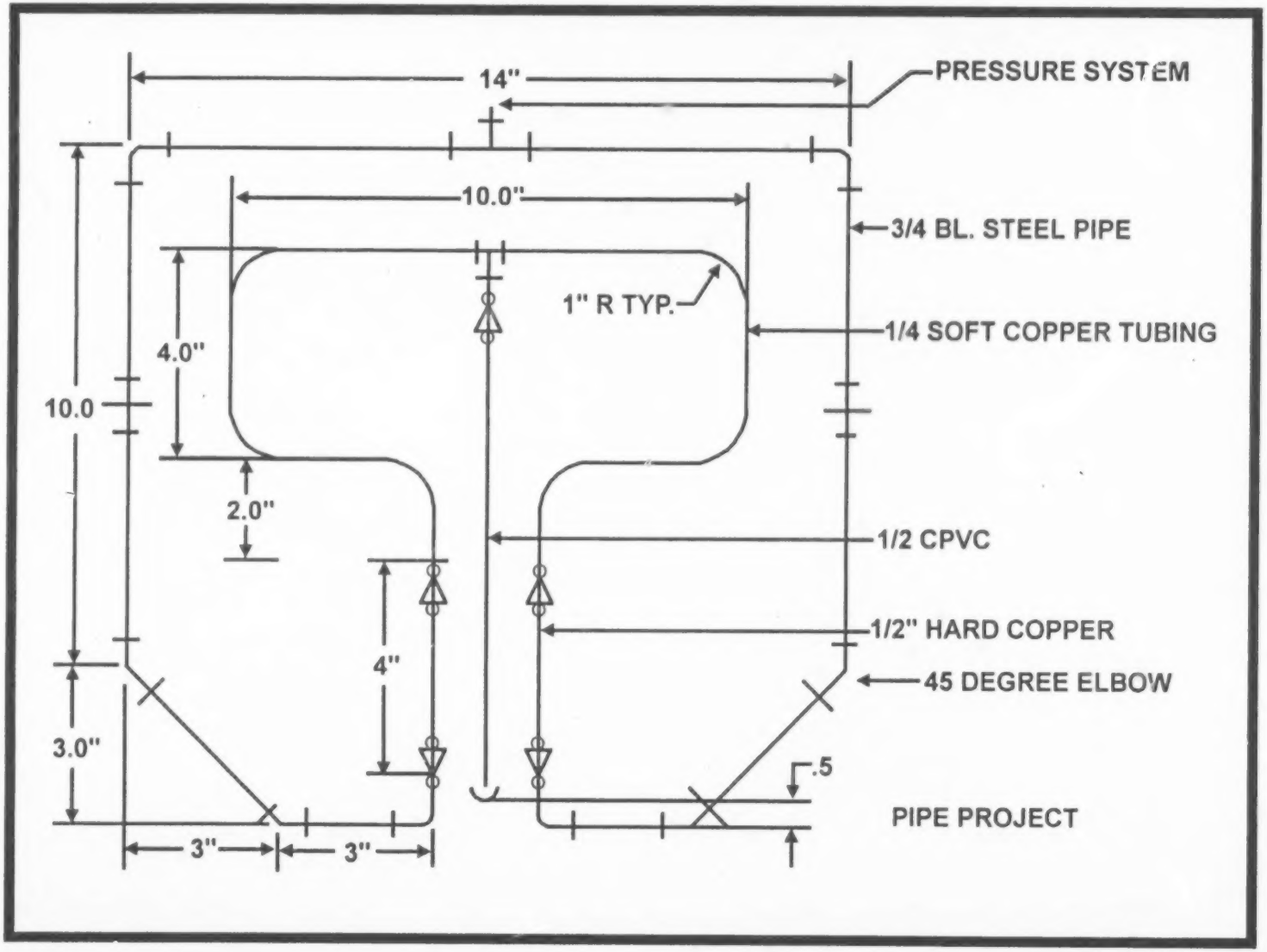
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join pipe in piping project;
   c. Join copper tubing by soldering in piping project;
   d. Join copper tubing with fittings, ferrule and flare in piping project; and,
   e. Join plastic tubing in piping project.


14"
PRESSURE SYSTEM
10.0"
3/4 BL. STEEL PIPE
1" R TYP.
1/4 SOFT COPPER TUBING
4.0"
10.0
2.0"
1/2 CPVC
1/2" HARD COPPER
4"
45 DEGREE ELBOW
3.0"
.5
PIPE PROJECT
3"
3"

Name:_____ Date:_____

IMM-K6
Fittings
Self-Assessment

Circle the letter preceding the most correct answer.

1. Most tubing fittings are threadless because tubing does not have the _____ needed.
   a. Length
   b. Shape
   c. Coating
   d. Wall thickness

2. The most commonly used fitting is the ell with the most common angles which are the _____ degree.
   a. 90 and 37-1/2
   b. 90 and 82
   c. 45 and 90
   d. 45 and 60

3. A straight tee means _____ threads.
   a. One outlet is 45°
   b. All outlets are the same size
   c. One outlet is reduced
   d. All outlets are different sizes

4. A nipple has _____ threads.
   a. A male and a female
   b. Two female
   c. One male and two female
   d. Two male

5. When reducing a pipe line in a straight run at a coupling a _____ would be used.
   a. Hexagon bushing
   b. Reducing tee
   c. Reducing ell
   d. Lateral

6. When a pipe line must end and not leak a _____ may be used.
   a. Tee or a coupling
   b. Plug or a cap
   c. Lateral or an elbow
   d. 45 degree elbow or a nipple

7. For ease in disconnecting and reconnecting a pipe line without disturbing the pipe's position a _____ may be used.
   a. Side outlet elbow
   b. Union
   c. Coupling
   d. Reducer

8. To tighten the bolts evenly on a pipe flange you should tighten _____.
   a. The opposite bolts in crossing
   b. In a clockwise direction
   c. In a counter clockwise direction
   d. Every other bolt

9. Welding fittings are supplied with _____.
   a. Tapered pipe threads
   b. Straight pipe threads
   c. Beveled ends
   d. Bell shaped ends

10. Each item for a welded fitting symbol may be identified by the _____.
   a. Parallel lines
   b. One line
   c. Circle
   d. Cross or x

IMM-K6
Fittings
Self-Assessment Answer Key

1. D
2. C
3. B
4. D
5. A
6. B
7. B
8. A
9. C
10. D

IMM-K7

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-K7

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Piping Operations
Task: Plastic Pipe

Objective(s):

Upon completion of this module the student will be able to:

a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Instructional Materials:

MASTER Handout (IMM-K7-HO)
MASTER Laboratory Aid (IMM-K7-LA)
MASTER Laboratory Worksheet (IMM-K7-LW)
MASTER Self-Assessment
Plastic Pipe
Pipe Compound

References:

Basic Plumbing, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition

Video: *Plumbing and Pipefitting 730*, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition

Tube Fittings, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-K6 "Fittings"

Introduction:

Plastic pipe has become a very important part of plumbing in industrial, commercial and residential use. It is corrosion resistant, has self-insulating properties, is free from rust or rot, light weight, easy to join, and low in cost. These factors have made it better in some applications than other pipe. Here we will learn of their use, applications and assembly in this section.

Presentation Outline:

I. Describe Plastic Pipe
   - A. Advantages
   - B. Thermoplastic piping
   - C. Thermosetting plastics
   - D. Limitations

II. Demonstrate Joining Plastic Pipe
   - A. Welding
   - B. Threaded joints

III. Identify Plastic Pipe Maintenance Procedures
   - A. Identify
   - B. Repair

Practical Application:

1. Join a coupling to plastic pipe by solvent welding.
2. Install a cap to CPVC by solvent welding.
3. Install plastic pipe to pipe project.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-L1) dealing with rigging fundamentals.

IMM-K7-HO
Plastic Pipe
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, Latest Edition

Chapter	Title
3	Plastic Piping

Module Outline:

I. Describe Plastic Pipe
   A. Advantages
   B. Thermoplastic piping
   C. Thermosetting plastics
   D. Limitations
II. Demonstrate Joining Plastic Pipe
   A. Welding
   B. Threaded joints
III. Identify Plastic Pipe Maintenance Procedures
   A. Identify
   B. Repair

IMM-K7-LA
Plastic Pipe
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join a coupling to plastic pipe by solvent welding;
   c. Install a cap to CPVC by solvent welding; and,
   d. Install plastic pipe to pipe project.

IMM-K7-LW
Plastic Pipe
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

2. Student will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

3. Instructor will grade student's ability to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

Name:_____ Date:_____

IMM-K7
Plastic Pipe
Self-Assessment

Circle the letter preceding the most correct answer.

1. One advantage plastic piping has over black iron pipe is _____.
   a. Heavier in weight
   b. Lower corrosion resistance
   c. Self-insulating
   d. Ease in threading

2. Generally speaking PVC is made from _____ major plastic group.
   a. Thermosetting
   b. Thermoplastic
   c. Plexiglass
   d. Vinyl

3. Salt solutions do not cause as many problem due to corrosion if it is carried in _____ pipe lines.
   a. Cast iron
   b. Copper
   c. Black iron
   d. PVC

4. One limitation of using plastic pipe is on _____ lines.
   a. Water supply
   b. Drain
   c. High pressures
   d. Sewage

5. When joining thermoplastic, PVC, ABS, and CAB plastic lines the _____ welding process is usually used.
   a. Solvent
   b. Fusion
   c. Fillet
   d. Arc

6. PE and similar plastics are joined by fusion welding using _____.
   a. Special heater
   b. Oxyacetylene torch
   c. Arc rod
   d. Chemical action

7. Plastic pipe may be threaded in limited cases and when the pipe is at least schedule _____.
   a. 20
   b. 40
   c. 60
   d. 80

8. When inspecting plastic pipe you should check for _____.
   a. Leaks, sagging and rust
   b. Leaks, sagging and out-of-round
   c. Needing repainting, sagging and rusting
   d. Sagging, leaks and needing repainting

9. Leaks are repaired by using _____ for the particular pipe material.
   a. Duct tape
   b. A special wood glue
   c. Correct solvent
   d. Special repair solvent

10. After repairs are made a drying time of _____ hours is needed.
   a. 2
   b. 4
   c. 8
   d. 10

IMM-K7
Plastic Pipe
Self-Assessment Answer Key:

1. C
2. B
3. D
4. C
5. A
6. A
7. D
8. B
9. C
10. D

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-L1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-L1

Subject: Industrial Maintenance **Time: 12 Hrs.**

Duty: Basic Rigging
Task: Rigging Fundamentals

Objective(s):

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;.
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Instructional Materials:

MASTER Handout (IMM-L1-HO)
MASTER Self-Assessment

References:

Blueprint Reading, TPC Publishers, Latest Edition
Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition
Reading Blueprints, Industrial Media, Inc., Latest Edition
Technology of Machine Tools, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K7 "Plastic Pipe"

Introduction:

Rigging allows one to gain mechanical advantage.

Presentation Outline:

I. Center of Gravity

II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

Practical Application:

1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-L2) dealing with demonstrating basic rigging skills.

IMM-L1-HO
Rigging Fundamentals
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Anderson, Audel Publishers, Latest Edition:

Chapters	Title
21	Rigging

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

Name:_____ Date:_____

IMM-L1
Rigging Fundamentals
Self-Assessment

1. The weight of a load is perfectly balanced around the
   a. Fulcrum.
   b. Center of gravity.
   c. Adjacent corners.
   d. Lift point.

2. If the load tilts down to the left when you perform a trial lift, move the hoisting point
   a. To the left.
   b. To the right.
   c. Forward.
   d. Backward.
   e. Up or down.

3. _____ is the strongest of the synthetic fiber ropes.
   a. Nylon
   b. Fiberglass
   c. Orlon
   d. Polypropylene

4. Chain is _____ than wire rope.
   a. More resistant to corrosion
   b. More resistant to abrasion
   c. Better when resistance to cutting caused by sharp bending is needed
   d. All of the above

5. To make sure chain is in good working condition _____ regularly.
   a. Inspect it
   b. Soak it in a mild acid solution
   c. Wash it with soap and water
   d. Stress test it, with a 105% capacity test load

6. A wire rope which has been kinked, can _____ when the strain is taken off.
   a. Break
   b. Fail
   c. Snarl
   d. Grip more securely

7. _____ slings are seldom used because of their weight.
   a. Manila
   b. Chain
   c. Nylon
   d. Wire rope

8. If the legs of a sling are spread further apart, the safe working load of the sling _____.
   a. Decreases
   b. Increases
   c. Is not affected
   d. Is spread out

9. Proper running of the ropes through a block and tackle system is called
   a. Lacing.
   b. Splicing.
   c. Reeving.
   d. Sheaving.

10. What is the name for the rope on the block and tackle, which is pulled on to exert force and lift the load?
   a. Lead line
   b. Tag line
   c. Byline
   d. Hook line

11. If a rope is too small for a sheave, it can
   a. Be pinched.
   b. Flatten out.
   c. Cut a groove in the sheave.
   d. Both b and c.

12. The _____ is the moving section of a derrick or crane, which supports the load.
   a. Base
   b. Boom
   c. Lead line
   d. Tag line

13. The _____ on an A-frame derrick should never be used for anything other than very light loads.
   a. Topping lift
   b. Working tackle
   c. Boom
   d. Lead line

14. Over extending the _____ on any type of crane or derrick can cause it to fail or collapse.
    a. Lead line
    b. Base
    c. Jib
    d. Boom

15. When moving a load up a ramp, a/an _____ is attached to the load to allow it to be safely moved up the ramp.
    a. Lever
    b. Inclined plane
    c. Wheel
    d. Snatch block

16. A heavy load lowered onto blacktop in hot weather can mire up without something to
    a. Spread out the pressure under it.
    b. Cool it off.
    c. Concentrate the pressure under the legs.
    d. Spread out its center of gravity.

17. _____ is not/are not a required safety item for rigging.
    a. A hardhat
    b. Rubber gloves
    c. Safety goggles
    d. Safety shoes

18. You should only exceed the rated capacity of hoisting equipment when
    a. Ordered to do so by your supervisor.
    b. Time is running out to complete the job.
    c. The load you are lifting is the last load of the day.
    d. Never.

IMM-L1
Rigging Fundamentals
Self-Assessment Answer Key

1. b
2. a
3. a
4. d
5. a
6. c
7. b
8. a
9. c
10. a
11. d
12. b
13. a
14. d
15. d
16. a
17. b
18. d

IMM-L2

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-L2

Subject: Industrial Maintenance **Time: 10 Hrs.**

Duty: Basic Rigging
Task: Demonstrate Basic Rigging Skills

Objective(s):

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage;
d. List two ways to construct a sling; and,
e. Demonstrate basic rigging skills.

Instructional Materials:

MASTER Handout (IMM-L2-HO)
MASTER Laboratory Worksheet (IMM-L2-LW)
MASTER Laboratory Aid (IMM-L2-LA)

References:

Blueprint Reading, TPC Publishers, Latest Edition
Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition
Reading Blueprints, Industrial Media, Inc., Latest Edition
Technology of Machine Tools, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-L1 "Rigging Fundamentals"

Introduction:

Rigging allows one to gain mechanical advantage. Successful demonstration proves a good understanding of rigging fundamentals.

Presentation Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

Practical Application:

1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-M1) dealing with plain bearings.

IMM-L2-HO
Demonstrate Basic Rigging Skills
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage;
d. List two ways to construct a sling; and,
e. Demonstrate basic rigging skills.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Anderson, Audel Publishers, Latest Edition::

Chapters	**Title**
21	Rigging

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

IMM-L2-LA
Demonstrate Basic Rigging Skills
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-L2-LW
Demonstrate Basic Rigging Skills
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

2. Student will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

3. Instructor will grade student's ability to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machine	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks											
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe					
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills										
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings										
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations										
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment										
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings								
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices							
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power							
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique					

IMM-M1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-M1

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Bearing Maintenance
Task: Plain Bearings

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Instructional Materials:

MASTER Handout (IMM-M1-HO)
MASTER Laboratory Aid (IMM-M1-LA)
MASTER Laboratory Worksheet (IMM-M1-LW)
MASTER Self-Assessment
Clean work area with parts washer
Arbor press
Hydraulic press
Bearing pullers
Good assortment of plain and roller bearings
Oil and grease with applicators
Hubs for pressure bearings into and removing then
Shafts for aligning bearings
Puller set
Bearing heater
Bearing separators
Table for mounting pillow block bearings
Necessary hand and measuring tools
Mounting dollies and sleeves

References:

Videos:

Bearing Maintenance, Industrial Training Inc. (ITI), 2023 Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Bearing Failure Analysis, Industrial Training Inc. (ITI), 2023 Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Bearings, MAJEC Training Consultants, Inc., Shawnee Mission, Kansas, Latest Edition

Maintaining Bearings, Tel-A-Trains, Mechanical Maintenance Series, 309 North Market Street, P.O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Bearing Failures and their Causes, SKF, Latest Edition

Also check with your bearing distributor.

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6	"Practice Safety" series
IMM-B1 through IMM-B6	"Apply Mathematical Concepts" series
IMM-C1 through IMM-C3	"Interpret Engineering Drawings and Control Documents" series
IMM-D1 through IMM-D2	"Use Measuring Tools" series
IMM-E1 through IMM-E2	"Use Hand Tools" series

Introduction:

Think of all the mechanical products we buy for work, play and the necessities of life. Almost all mechanical devices are composed of many different shapes, sizes and materials. Bearings, in these mechanical devices, support and insure that the parts move smoothly and easily to give long trouble-free life. In this section we will learn about plain bearings.

Presentation Outline:

I. Describe the Principles of Plain Bearings
   - A. Introduction of bearings
   - B. Lubrication
   - C. Reason for soft bearing materials

II. Identify the Types and Materials of Plain Bearings
   - A. Journal bearings

B. Thrust bearings
C. Linear bearings
D. Material characteristics
E. Material types and uses

III. Demonstrate Maintenance Practices for Plain Bearings
A. General
B. Assembly
C. Cleaning
D. Relining journal bearings
E. Start-up

IV. Identify Failure Patterns of Plain Bearings
A. Operating symptoms
B. Symptoms found on inspection
C. Causes of failure

Practical Application:

1. Install shaft in two plain pillows block bearings;
2. Align, secure bearings to table and secure shaft to bearings;
3. Remove old bearing and press plain bearing in housing using proper tools and procedures;
4. Check inside diameter and shaft for proper fit;
5. Hone to size if necessary;
6. Lubricate bearings; and,
7. Run and troubleshoot bearing and shaft assemblies.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-M2) dealing with rolling element bearings.

IMM-M1-HO
Plain Bearings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance,*** Dick Jeffrey, ISBN 0170087050, Delmar/I.T.P., Latest Edition:

Chapter	Title
6.1	Plain Bearings

Module Outline:

I. Describe the Principles of Plain Bearings
   A. Introduction of bearings
   B. Lubrication
   C. Reason for soft bearing materials
II. Identify the Types and Materials of Plain Bearings
   A. Journal bearings
   B. Thrust bearings
   C. Linear bearings
   D. Material characteristics

E. Material types and uses

III. Demonstrate Maintenance Practices for Plain Bearings
- A. General
- B. Assembly
- C. Cleaning
- D. Relining journal bearings
- E. Start-up

IV. Identify Failure Patterns of Plain Bearings
- A. Operating symptoms
- B. Symptoms found on inspection
- C. Causes of failure

IMM-M1-LA
Plain Bearings
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install shaft in two plain pillows block bearings;
   c. Align, secure bearings to table and secure shaft to bearings;
   d. Remove old bearing and press plain bearing in housing using proper tools and procedures;
   e. Check inside diameter and shaft for proper fit;
   f. Hone to size if necessary;
   g. Lubricate bearings; and,
   h. Run and troubleshoot bearing and shaft assemblies.

IMM-M1-LW
Plain Bearings
Attachment 3: **MASTER** Laboratory Worksheet

Review the general section under maintenance practices pages of text (reading assignment) prior to performing practical applications.

Name:_____ Date:_____

IMM-M1
Plain Bearings
Self-Assessment

Circle the letter preceding the most correct answer.

1. Plain bearing are described as having _____.
   a. Balls in two raceways
   b. Two surfaces sliding together
   c. Rollers in two raceways
   d. Pins in two raceways

2. In plain bearings the two surfaces must be _____ and _____ to provide minimum resistance.
   a. Rough sanded and dry
   b. Knurled and lubricated
   c. Smooth and lubricated
   d. Smooth and dry

3. In a plain bearing the material of the bearing is _____ than the shaft.
   a. Softer
   b. Longer
   c. Harder
   d. Rougher

4. The linear plain bearing with a GIB adjustment is a _____.
   a. Single-slide
   b. Double-slide
   c. V-angled way
   d. Dovetail

5. If a plain bearing does not have a material with conform ability it is very necessary to insure _____ during installation.
   a. Extra lubrication is used
   b. Minimum clearance is provided
   c. Proper alignment
   d. Clean mounting

6. Before pressing a plain bearing into a housing check the _____ of the shaft and housing.
   a. Dimensions
   b. Hardness
   c. Softness
   d. Flatness

7. If at all possible a plain bearing should be installed by using _____.
   a. Sledge hammer
   b. An arbor press
   c. Wood block and hammer
   d. An oxyacetylene torch

8. The clearance and roundness of the bearing a shaft may be checked with _____.
   a. Outside and inside calipers
   b. A 12' steel tape
   c. A folding rule
   d. A micrometer and gage

9. The first thing to check before running the shaft in the plain bearing is alignment using _____ to indicate wear spots.
   a. Teflon tape
   b. Bluing
   c. Pipe dope
   d. Shin stock

10. Of the operating symptoms of plain bearing failure _____ could cause extensive equipment damage.
   a. Noise
   b. Vibration
   c. Seizure
   d. Overheating

IMM-M1
Plain Bearings
Self-Assessment Answer Key

1. B
2. C
3. A
4. D
5. C
6. A
7. B
8. D
9. B
10. C

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-M2

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Bearing Maintenance
Task: Rolling Element Bearings

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Instructional Materials:

MASTER Handout (IMM-M2-HO)
MASTER Laboratory Aid (IMM-M2-LA)
MASTER Laboratory Worksheet (IMM-M2-LW)
MASTER Self-Assessment
Clean work area with parts washer
Arbor press
Hydraulic press
Bearing pullers
Good assortment of plain and roller bearings
Oil and grease with applicators
Hubs for pressure bearings into and removing them
Shafts for aligning bearings
Puller set
Bearing heater
Bearing separators
Table for mounting pillow block bearings
Necessary hand and measuring tools
Mounting dollies and sleeves

References:

Videos:

Bearing Maintenance, Industrial Training Inc. (ITI), 2023 Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Bearing Failure Analysis, Industrial Training Inc. (ITI), 2023 Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Bearings, MAJEC Training Consultants, Inc., Shawnee Mission, Kansas, Latest Edition

Maintaining Bearings, Tel-A-Trains, Mechanical Maintenance Series, 309 North Market Street, P.O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Bearing Failures and their Causes, SKF, Latest Edition

Also check with your bearing distributor.

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6	"Practice Safety" series
IMM-B1 through IMM-B6	"Apply Mathematical Concepts" series
IMM-C1 through IMM-C3	"Interpret Engineering Drawings and Control Documents" series
IMM-D1 through IMM-D2	"Use Measuring Tools" series
IMM-E1 through IMM-E2	"Use Hand Tools" series

Introduction:

Think of all the mechanical products we buy for work, play and the necessities of life. Almost all mechanical devices are composed of many different shapes, sizes and materials. Bearings, in these mechanical devices, support and insure that the parts move smoothly and easily to give long trouble-free life. In this section we will learn about rolling element bearings.

Presentation Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   - A. Introduction
   - B. Ball bearings
   - C. Roller bearings
   - D. Linear bearings

II. Identify the Types of Rolling Elements Bearings

A. Journal bearings
B. Thrust bearings

III. Describe Roller Element Bearing Assembly Design
A. Shaft and housing fits
B. Thermal expansion
C. Types of mountings

IV. Demonstrate Maintenance Practices of Roller Element Bearings
A. General
B. Tools and equipment
C. Mounting procedures
D. Pre-lubrication
E. Selection of mounting method
F. Special considerations
G. Dismounting procedures

V. Identify Failure Patterns of Rolling Element Bearings
A. Operating symptoms
B. Symptoms found on inspection
C. Cause of failure

Practical Application:

1. Install a shaft in two self-aligning pillow block bearing with rolling element bearings;
2. Change the rolling element bearing in a self aligning pillow block to a different size;
3. Remove a rolling element bearing from a shaft and install another bearing;
4. Remove a rolling element bearing form a housing and install another bearing; and,
5. Clean and pre-lubricate a rolling element bearing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-N1) dealing with basic word processing operations.

IMM-M2-HO
Rolling Element Bearings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ITP Publishing, Latest Edition

Chapter	**Title**
6.2	Rolling Element Bearings

Module Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   A. Introduction
   B. Ball bearings
   C. Roller bearings
   D. Linear bearings
II. Identify the Types of Rolling Elements Bearings
   A. Journal bearings
   B. Thrust bearings

III. Describe Roller Element Bearing Assembly Design
   A. Shaft and housing fits
   B. Thermal expansion
   C. Types of mountings
IV. Demonstrate Maintenance Practices of Roller Element Bearings
   A. General
   B. Tools and equipment
   C. Mounting procedures
   D. Pre-lubrication
   E. Selection of mounting method
   F. Special considerations
   G. Dismounting procedures
V. Identify Failure Patterns of Rolling Element Bearings
   A. Operating symptoms
   B. Symptoms found on inspection
   C. Cause of failure

IMM-M2-LA
Rolling Element Bearings
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install a shaft in two self aligning pillow block bearing with rolling element bearings;
   c. Change the rolling element bearing in a self aligning pillow block to a different size;
   d. Remove a rolling element bearing from a shaft and install another bearing;
   e. Remove a rolling element bearing form a housing and install another bearing; and,
   f. Clean and pre-lubricate a rolling element bearing.

IMM-M2-LW
Rolling Element Bearings
Attachment 3: **MASTER** Laboratory Worksheet

Review the general section, under maintenance practices pages of text (reading assignment) prior to performing practical applications.

6. New bearings should be kept _____ until you are ready to mount it.
   a. In solvent
   b. Covered in used motor oil
   c. Wrapped in its paper
   d. Covered in water

7. Rolling element bearings usually may be cold mounted if thy are less than _____ inches in diameter.
   a. 10
   b. 8
   c. 6
   d. 4

8. When using a sleeve to press a rolling element bearing onto a shaft the sleeve should rest on the _____ interference fit.
   a. Ball assembly next to the
   b. Cage next to the
   c. Bearing ring closes to the
   d. Bearing ring away from the

9. When hot mounting a rolling element bearing the bearing should never be heated above _____ degrees F.
   a. 150
   b. 250
   c. 350
   d. 450

10. The single most common cause of rolling element bearing failure is _____.
   a. Lack of lubrication
   b. Moisture
   c. Dirt
   d. Electric currents

6. New bearings should be kept _____ until you are ready to mount it.
   a. In solvent
   b. Covered in used motor oil
   c. Wrapped in its paper
   d. Covered in water

7. Rolling element bearings usually may be cold mounted if thy are less than _____ inches in diameter.
   a. 10
   b. 8
   c. 6
   d. 4

8. When using a sleeve to press a rolling element bearing onto a shaft the sleeve should rest on the _____ interference fit.
   a. Ball assembly next to the
   b. Cage next to the
   c. Baring ring closes to the
   d. Bearing ring away from the

9. When hot mounting a rolling element bearing the bearing should never be heated above _____ degrees F.
   a. 150
   b. 250
   c. 350
   d. 450

10. The single most common cause of rolling element bearing failure is _____.
   a. Lack of lubrication
   b. Moisture
   c. Dirt
   d. Electric currents

IMM-M2
Rolling Element Bearings
Self-Assessment Answer Key

1. C
2. B
3. D
4. B
5. A
6. C
7. D
8. C
9. B
10. A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working shift	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacety lene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Trouble-shoot centrifugal pumps	H-4 Trouble-shoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Trouble-shoot and repair blowers	H-8 Trouble-shoot, maintain, and repair hydraulic systems	H-9 Trouble-shoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

9:6

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INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-N1

Subject: Industrial Maintenance **Time: 30 Hrs.**

Duty: Use Computers
Task: Perform Basic Word Processing

Objective(s):

Upon completion of this module the student will be able to:

a. Create a document;
b. Edit a document;
c. Select fonts;
d. Cut, copy, and paste;
e. Select tab and indent;
f. Get help;
g. Use speller and thesaurus;
h. Find and replace;
i. Create header and footer;
j. Create tables;
k. Use columns; and,
l. Import and export graphics.

Instructional Materials:

MASTER Handout (IMM-N1-HO)
MASTER Laboratory Worksheet (IMM-N1-LW)
MASTER Laboratory Aid (IMM-N1-LA)
MASTER Self-Assessment
Computer with word processing software loaded (Windows preferred)

References:

Learning WordPerfect, Shelly & Cashman, Boyd & Frazier Publishers, Latest Edition
MS Word, Microsoft Press, Latest Edition
Learning Word, Shelly & Cashman, Boyd & Frazier Publishers, Latest Edition
WordPerfect For Windows, QUE Publishers, Latest Edition
PFS: Windows Works, Spinnaker Publishers, Latest Edition

Student Preparation:

Introduction:

Word processing on a computer, in conjunction with a printer, replaces a typewriter. Also, a word processor allows for ease in changing text, graphics, tables, and columns. Many technicians are required to produce reports, memos, etc. A basic understanding of a word processor allows the technician to generate and alter documents.

Presentation Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics

Practical Application:

1. Instructor will demonstrate steps to produce documents using a word processor.

2. Student will demonstrate steps to produce documents using a word processor.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-N2) dealing with basic spreadsheet operations.

IMM-N1-HO
Perform Basic Word Processing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the computer laboratory by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Create a document;
b. Edit a document;
c. Select fonts;
d. Cut, copy, and paste;
e. Select tab and indent;
f. Get help;
g. Use speller and thesaurus;
h. Find and replace;
i. Create header and footer;
j. Create tables;
k. Use columns; and,
l. Import and export graphics.

Reading Assignments:

The following chapters are assigned to read from *Learning WordPerfect* by Corel Corp., Latest Edition:

Section	Title
1	Creating a Document
1	Editing a Document
1	Selecting Fonts
1	Using Cut, Copy, and Paste
2	Using Tab and Indent
2	Using Help
3	Using Speller and Thesaurus
3	Find and Replace
3	Headers and Footers
3	Tables
4	Columns
4	Graphics

Module Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics

The students will:

a. Follow housekeeping rules set up by instructor and school;
b. Follow closely instructions given by instructor;
c. Do not go faster than instructor, this could create problems;
d. If unable to follow instructor, let instructor know; and,
e. Ask questions if steps are not clear.

IMM-N1-LW
Perform Basic Word Processing
Attachment 3: **MASTER** Laboratory Worksheet

The students will:

a. Practice using software commands;
b. After practicing setting up spreadsheet, proceed to creating charts; and,
c. After practicing creating charts, let instructor know that you are ready to take performance measure.

Name:_____ Date:_____

IMM-N1
Perform Basic Word Processing
Self-Assessment

Instructions: Circle the correct response.

Word

1. To set the top, bottom, left, and right margins in a word processing document, use the _____.
   A. Page Setup command from the File Menu
   B. Headers and Footers command from the View Menu
   C. Paragraph command from Format Menu
   D. Options command from the Tools Menu

2. The Headers and Footers command is found on the _____ menu.
   A. File
   B. Edit
   C. View
   D. Format

3. The entry in the Headers and Footers dialog box to specify printing the page number in the header is _____.
   A. &page
   B. &number
   C. &p
   D. #

4. In normal view, a header created the Headers and Footers command will _____.
   A. Display at the top of each screen unless certain boxes have been selected
   B. Display on the screen only when there is a page break mark on the screen
   C. Print at the top of each page unless certain boxes have been selected
   D. Display on the screen and print at the top of each page unless certain boxes have been selected

5. Dragging the first-line indent marker on the ruler one-half inch to the right will cause _____.
   A. All lines typed to be indented one-half inch
   B. All new sentences to be indented one-half inch
   C. The first line of each paragraph to be indented one-half inch
   D. The first line each paragraph to be indented one-half inch if you press the TAB key

6. When you choose the Footnote command from the Insert menu, _____.
   A. A footnote panel appears at the top of the screen allowing you to type the footnote
   B. A footnote panel appears at the end of the document allowing you to select a number or a character as a footnote reference mark
   C. A footnote dialog box displays in the footnote panel
   D. A footnote dialog box displays in the center of the screen allowing you to select a numbered footnote or a character

7. To cause a manual page break to occur on a document _____.
   A. Choose the Break command in the Insert Menu
   B. Press CTRL+ALT
   C. Press CRTL+SHIFT
   D. Press SHIFT+ENTER

8. The command used to replace one or more words at time in a document with another word or words is the _____ command.
   A. Find
   B. Go To
   C. Thesaurus
   D. Replace

9. The Works drag-and-drop method may be used to _____.
   A. Move text from one location to another in a document
   B. Copy text from one location to the another location in a document with the copied text remaining in its original position
   C. Position footnotes at the end of a document
   D. Both A and B

10. To create a table in a word processing document, you can use the _____.
   A. Insert Table button on the Toolbar
   B. Spreadsheet/Table command from the Insert menu
   C. Object command from the Insert menu
   D. A, B, and C

IMM-N1
Perform Basic Word Processing
Self-Assessment Answer Key

1. A
2. C
3. D
4. C
5. A
6. D
7. A
8. D
9. D
10. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-N2

Subject: Industrial Maintenance **Time: 8 Hrs.**

Duty: Use Computers
Task: Perform Basic Spreadsheet Operations

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Instructional Materials:

MASTER Handout (IMM-N2-HO)
MASTER Laboratory Aid (IMM-N2-LA)
MASTER Laboratory Worksheet (IMM-N2-LW)
MASTER Self-Assessment
Computer with spreadsheet software (E.g.: Excel, Lotus 123, Window Works)

References:

PFS: Window Works, Spinnaker Corp., Latest Edition
Lotus 123, Shelly & Cashman, Boyd & Frazier Publishers, Latest Edition
MS Excel, Shelly & Cashman, Boyd & Frazier Publishers, Latest Edition
MS Excel, Microsoft Press, Latest Edition
Learning Excel, DDC Publishing, Latest Edition
Microsoft Excel, Logical Operations Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-N1 "Perform Basic Word Processing"

Introduction:

Spreadsheets allows a person to organize subject areas and separate by fields.

Presentation Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet

Practical Application:

1. Instructor will demonstrate how to use the software commands to create spreadsheets and charts.

2. Student will demonstrate how to use the software command to create spreadsheets and charts.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-O1) dealing with principles of alignment.

IMM-N2-HO
Perform Basic Spreadsheet Operations
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the computer lab.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Reading Assignments:

The following chapters are assigned to read from *PFS: Window Works* by Spinnaker Publishing Co., Latest Edition:

Chapters	Title
11	File Menu Commands
11	Edit Menu Commands
11	Format Menu Commands
11	Create Chart

Module Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet

IMM-N2-LA
Perform Basic Spreadsheet Operations
Attachment 2: **MASTER** Laboratory Aid

---

1. Follow housekeeping rules set up by instructor and school;
2. Follow closely instructions given by instructor;
3. Do not go faster than instructor; this could create problems;
4. If unable to follow instructor, let instructor know; and,
5. Ask questions if steps are not clear.

IMM-N2-LW
Perform Basic Spreadsheet Operations
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Practice using software commands;
2. After practicing setting up spreadsheet, proceed to creating charts; and,
3. After practicing creating charts, let instructor know that you are ready to take Self-Assessment.

Name:_____ Date:_____

IMM-N2
Perform Basic Spreadsheet Operations
Self-Assessment

Instructions : Circle the correct response.

Excel

1. You can highlight a cell by _____.
   A. Clicking the cell while the mouse pointer is in the cell
   B. Pressing an arrow key until the desired cell is outlined with a heavy border
   C. Both A and B
   D Neither A nor B

2. The column titles, September, October, November, and December, can be conveniently placed in a spreadsheet by using the _____ command.
   A. Fill series
   B. Fill right
   C. Replace
   D. Select all

3. A _____ is a block of adjacent cells in a spreadsheet.
   A. Range
   B. Group
   C. Highlight
   D. Format

4. Clicking the Autosum button two times is the same as _____.
   A. Clicking the Autosum button one time and pressing the RIGHT ARROW key
   B. Clicking the Autosum button one time and clicking the Enter box
   C. Clicking the Autosum button one time
   D. Clicking the Autosum button and clicking the Currency button on the Toolbar

5. To change the width of more than one column at a time, you must first _____ .
   A. Highlight cell A1
   B. Highlight any cell in the beginning column
   C. Highlight at least one cell in every column you want to change
   D. Highlight the entire spreadsheet

6. To remove the highlighting from a group of cells, _____.
   A. Click any cell on the spreadsheet
   B. Choose the Clear command from the Edit menu
   C. Click the Cut button on the Toolbar
   D. Press the DELETE key on the keyboard

7. To save your spreadsheet the first time, choose the _____.
   A. Save As button on the Toolbar
   B. Startup button on the Toolbar
   C. Close button on the Toolbar
   D. Save button on the Toolbar

8. To create a chart, highlight the portion of the spreadsheet to be charted and then _____.
   A. Choose the New Chart command from the View menu
   B. Click the New Chart button on the Toolbar
   C. Choose the Options command from the Tools menu
   D. Select the Window menu

9. To delete a character in the formula bar, _____.
   A. Place the insertion point to the right of the character to delete and press the DELETE key
   B. Place the insertion point to the right of the character to delete and press the BACKSPACE key
   C. Place the insertion point to the left of the character to delete and press the SPACEBAR
   D. Place the insertion point of the left of the character to delete and press the BACKSPACE key

10. To remove the contents and formatting of a highlighted cell, _____.
   A. Press the DELETE key
   B. From the EDIT menu, choose the Clear command
   C. Click the Cut button on the Toolbar
   D. From the Edit menu, choose the Delete command

IMM-N2
Perform Basic Spreadsheet Operations
Self-Assessment Answer Key

1. C
2. B
3. B
4. B
5. C
6. A
7. A
8. B
9. B
10. A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Tasks →

Duties													
K	**Piping Operations**	K-1 Perform basic pipefitting calculations	K-2 Cut, thread and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe					
L	**Basic Rigging**	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills										
M	**Bearing Maintenance**	M-1 Plain bearings	M-2 Rolling element bearings										
N	**Use Computers**	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations										
O	**Align Shafts**	O-1 Principles of alignment	O-2 Methods of alignment										
P	**Install/Align Machines**	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings								
Q	**Maintain Electrical Devices**	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices							
R	**Basic Mechanical Concepts**	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power							
S	**Fasteners and Preloading**	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique					

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INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-O1

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Align Shafts
Task: Principles of Alignment

Objective(s):

Upon completion of this module the student will be able to:

a. Describe misalignment;
b. Identify tolerances for alignment;
c. Describe adjustments procedures;
d. Demonstrate how to align using a dial indicators;
e. Describe thermal growth; and,
f. Demonstrate doweling after alignment.

Instructional Materials:

MASTER Handout (IMM-O1-HO)
MASTER Laboratory Aid (IMM-O1-LA)
MASTER Laboratory Worksheet (IMM-O1-LW)
MASTER Self-Assessment
Steel plate 2" x 6"
Drills and ream
1/4 x 1/2 dowel pins
Tools necessary to complete the project

References:

Mechanics' and Millwrights' Guide (Audel), Macmillan Publishing Company, Latest Edition

Videos: *Couplings,* Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Coupling Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Video Laser Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6	"Practice Safety" series
IMM-B1 through IMM-B6	"Apply Mathematical Concepts" series
IMM-C1 through IMM-C3	"Interpret Engineering Drawings and Control Documents" series
IMM-D1 through IMM-D2	"Use Measuring Tools" series
IMM-E1 through IMM-E2	"Use Hand Tools" series

Introduction:

It is very important to insure shaft alignment is as close as possible. Poor alignment may cause critical damage to drives and equipment due to excessive vibration. This vibration could damage to bearings, seals, couplings and other machine elements. After completion of this section you will better understand the principles of shaft alignment and doweling.

Presentation Outline:

I. Describe Misalignment
   - A. Parallel misalignment
   - B. Angular misalignment
   - C. Combination misalignment

II. Identify Tolerances for Alignment
   - A. Coupling manufacturers
   - B. Machinery manufacturers
   - C. Special conditions

III. Describe Adjustment Procedures
   - A. Unit to adjust
   - B. Distance and soft foot
   - C. Equipment rocking (soft-foot)
   - D. Vertical alignment first

IV. Determine How to Align Using a Dial Indicator
   - A. Introduction to a dial indicator
   - B. Total indicator run-out

V. Describe Thermal Growth
   - A. Effects of temperature
   - B. Aligning steam turbines

VI. Demonstrate Doweling after Alignment
   A. Purpose
   B. Location

Practical Application:

1. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
2. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-O2) dealing with methods of alignment.

IMM-O1-HO
Principles of Alignment
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe misalignment;
b. Identify tolerances for alignment;
c. Describe adjustments procedures;
d. Demonstrate how to align using a dial indicators;
e. Describe thermal growth; and,
f. Demonstrate doweling after alignment.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operations and Maintenance,*** Dick Jeffrey, Delmar Publishing/ATP, Latest Edition:

Chapter	Title
8	Shaft Alignment

Module Outline:

I. Describe Misalignment
   A. Parallel misalignment
   B. Angular misalignment
   C. Combination misalignment
II. Identify Tolerances for Alignment
   A. Coupling manufacturers
   B. Machinery manufacturers

C. Special conditions

III. Describe Adjustment Procedures
- A. Unit to adjust
- B. Distance and soft foot
- C. Equipment rocking (soft-foot)
- D. Vertical alignment first

IV. Determine How to Align Using a Dial Indicator
- A. Introduction to a dial indicator
- B. Total indicator run-out

V. Describe Thermal Growth
- A. Effects of temperature
- B. Aligning steam turbines

VI. Demonstrate Doweling after Alignment
- A. Purpose
- B. Location

IMM-O1-LA
Principles of Alignment
Attachment 2: **MASTER** Laboratory Aid

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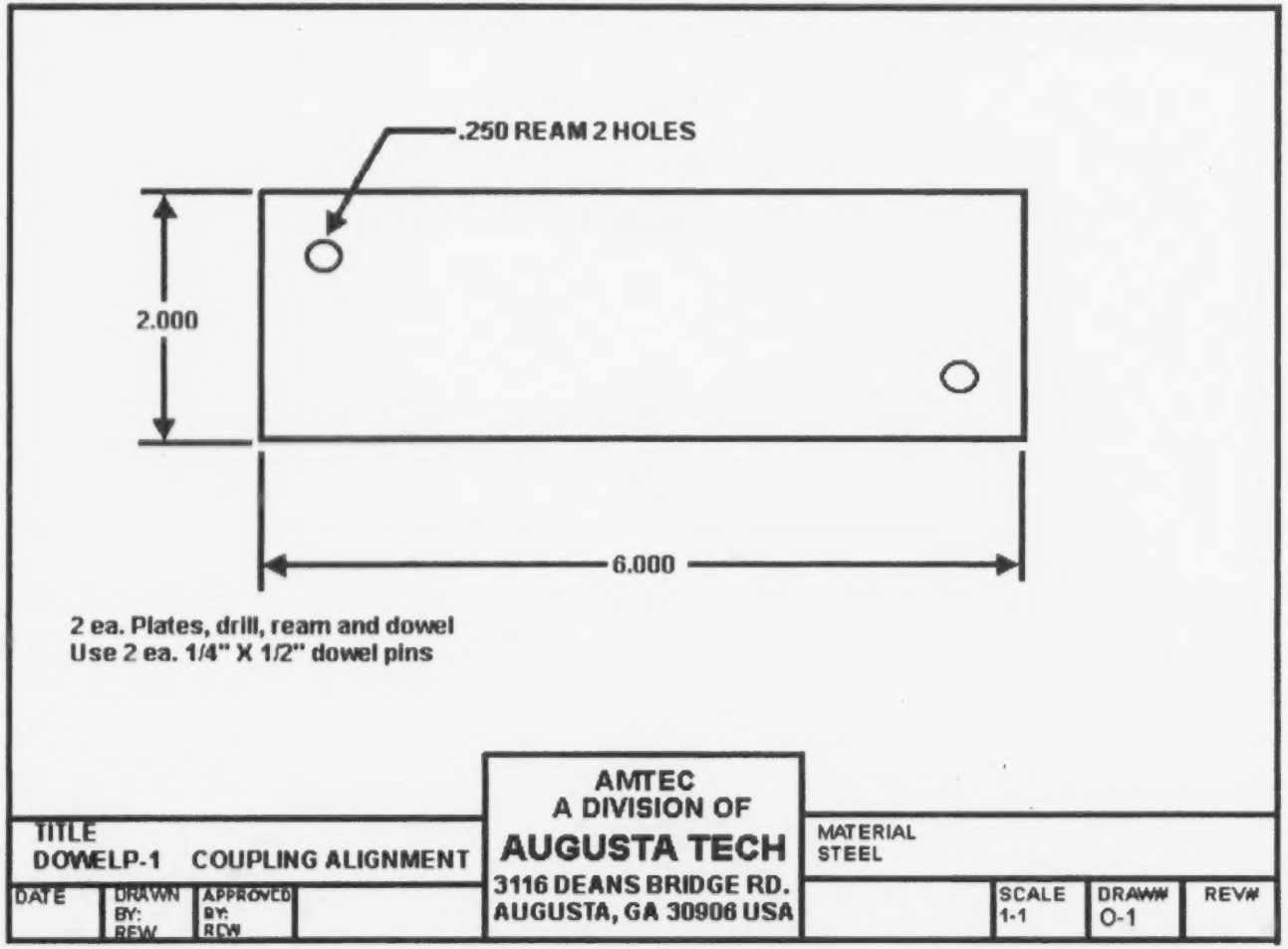
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
   c. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.


.250 REAM 2 HOLES
2.000
6.000
2 ea. Plates, drill, ream and dowel
Use 2 ea. 1/4" X 1/2" dowel pins
TITLE
DOWELP-1 COUPLING ALIGNMENT
AMTEC
A DIVISION OF
AUGUSTA TECH
3116 DEANS BRIDGE RD.
AUGUSTA, GA 30906 USA
MATERIAL
STEEL
DATE
DRAWN BY: REW
APPROVED BY: RCW
SCALE 1-1
DRAWN O-1
REV#

Name:_____ Date:_____

IMM-O1
Principles of Alignment
Self-Assessment

Circle the letter preceding the most correct answer.

1. If the driven unit shaft is level but the driver unit front is higher than the rear is called _____ misalignment.
   a. Foot
   b. Soft foot
   c. Angular
   d. Parallel

2. Coupling alignment becomes more critical with _____.
   a. High speeds and with high power transmission
   b. Slow speed and with high power transmission
   c. Low speed and with low torque
   d. Small sump pumps

3. When performing coupling alignment it is normal to adjust the _____.
   a. Front pulley
   b. Gear shaft
   c. Driven machine
   d. Driving machine

4. The shaft of the driven machine should be approximately _____ inches higher than the driving machine for coupling alignment.
   a. .002
   b. .050
   c. .125
   d. .250

5. The dial indicator should be zeroed when the plunger is _____.
   a. At midway of the travel
   b. Reading .010"
   c. Fully depressed
   d. Reading .050"

6. If a dial indicator is zeroed at the top position and the shaft is rotated 180 degrees and then reads .025 inches the total run out is _____ inches.
   a. .0375
   b. .0125
   c. .025
   d. .050

7. If a dial indicator is zeroed at the top position and the shaft is rotated 180 degrees and then reads .025 inches the center line of the two shafts are _____ inches out of line.
   a. .0375
   b. .0125
   c. .025
   d. .050

8. If a dial indicator plunger is depressed the reading is _____.
   a. Doubled
   b. 1/2 the reading
   c. Negative
   d. Positive

9. If the thermal expansion is evident in alignment the driving shaft should be _____ than the driven shaft.
   a. Larger
   b. Smaller
   c. Set lower
   d. Set higher

10. After the couplings have been properly aligned dowel pins should be positioned _____.
   a. With two pins on each foot
   b. 2 inches a part
   c. 4 inches a part
   d. As far a part as possible

IMM-O1
Principles of Alignment
Self-Assessment Answer Key

1. C
2. A
3. D
4. B
5. A
6. C
7. B
8. D
9. C
10. D

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-O2

Subject: Industrial Maintenance **Time: 10 Hrs.**

Duty: Align Shafts
Task: Methods of Alignment

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

Instructional Materials:

MASTER Handout (IMM-O2-HO)
MASTER Laboratory Aid (IMM-O2-LA)
MASTER Laboratory Worksheet (IMM-O2-LW)
MASTER Self-Assessment
Two dial indicators with clamps
Couplings and shafts
Four pillow block bearings
Shim stock
6" steel rule
Feeler gage set
Tools necessary to complete the project

References:

Mechanics' and Millwrights' Guide (Audel), Macmillan Publishing Company, Latest Edition

Videos: *Couplings,* Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Coupling Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Video Laser Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-O1 "Principles of Alignment."

Introduction:

It is very important to insure shaft alignment is as close as possible. Poor alignment may cause critical damage to drives and equipment due to excessive vibration. This vibration could damage the bearings, seals, couplings and other machine elements. After completing this section you will be able to align couplings several ways.

Presentation Outline:

I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
   B. Parallel misalignment
   C. Tolerances
II. Describe the Face and Rim Method of Aligning Couplings
   A. Introduction
   B. Short comings
III. Set-Up and Align Couplings Using the Reverse Indicator Method
   A. Advantages of
   B. Procedures for aligning
IV. Describe the General Hints on Alignment
   A. Measuring tools and shims
   B. Equipment

Practical Application:

1. Align a coupling using the straight edge and feeler gage method; and,
2. Align a coupling using dial indicators.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P1) dealing with installing electrical connections.

IMM-O2-HO
Methods of Alignment
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operations and Maintenance***, Dick Jeffrey, Delmar Publishing, ATP, Latest Edition:

Chapter	Title
8	Shaft Alignment

Module Outline:

I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
   B. Parallel misalignment
   C. Tolerances
II. Describe the Face and Rim Method of Aligning Couplings
   A. Introduction
   B. Short comings
III. Set-Up and Align Couplings Using the Reverse Indicator Method
   A. Advantages of

B. Procedures for aligning

IV. Describe the General Hints on Alignment

A. Measuring tools and shims

B. Equipment

IMM-O2-LA
Methods of Alignment
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Align a coupling using the straight edge and feeler gage method; and,
   c. Align a coupling using dial indicators.

IMM-O2-LW
Methods of Alignment
Attachment 3: **MASTER** Laboratory Worksheet

Review:

a. General hints on alignment; and,
b. Pages in textbook on alignment.

Name:_____ Date:_____

IMM-O2
Methods of Alignment
Self-Assessment

Circle the letter preceding the most correct answer.

1. The simplest, easiest and least accurate method of aligning shafts is the _____ method.
   a. 25 foot tape rule
   b. Straight edge and feeler gage
   c. Dial indicator
   d. Laser

2. The straight edge and feeler gage method is only recommended with flexible coupling with tolerances of _____.
   a. High horse power and fast speeds
   b. Low horse power and fast speeds
   c. 15 degrees and .010" parallel
   d. 1 degree and .001" parallel run-out

3. When using the face and ream method of aligning couplings the indicator is rotated 360 degrees with readings taken at ever _____ degree intervals.
   a. 30
   b. 45
   c. 60
   d. 90

4. One of the advantages of the reverse indicator method over the face and rim method is the _____ does not need to be removed.
   a. Driven shaft
   b. Thrust bearings
   c. Coupling spacer
   d. Driver shaft

5. If the dial indicator method is used it is necessary to check _____ in the face and rim as well as the reverse indicator method.
   a. For dial indicator support bracket deflection
   b. The thrust bearings in the driving unit
   c. The temperature of the shaft
   d. Feeler gage roughness

6. The dial indicator plunges should bear on the _____ when using the reverse indicator method.
   a. Coupling spacer
   b. O.D. of coupling hubs or shaft
   c. I.D. of the coupling
   d. Face of the couplings

7. The driven and the driving machine shafts may be roughly centered by checking the reading _____ degrees from top dead center.
   a. 90 and 270
   b. 45 and 225
   c. 30 and 210
   d. 60 and 240

8. When mounting both indicators on driving and driven couplings insure both may be rotated _____ degrees without interference.
   a. 90
   b. 180
   c. 270
   d. 360

9. Suppose both indicators are zeroed at top dead center and rotated 180 degrees and reread. This operation is checking the _____.
   a. Bearing wear or adjustment
   b. Coupling bore
   c. Vertical and/or angular misalignment
   d. Scaring of driver shaft

10. Before using a dial indicator check to see if _____.
   a. The plunger sticks
   b. It is a .0001 reading indicator
   c. It has a 2 inch travel
   d. The needle is bent

IMM-O2
Methods of Alignment
Self-Assessment Answer Key

1. B
2. C
3. D
4. C
5. A
6. B
7. A
8. D
9. C
10. A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-P1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

· MASTER Technical Module No. IMM-P1

Subject: **Industrial Maintenance** **Time: 6 Hrs.**

Duty: **Install/Align Machines**
Task: Install Electrical Connections

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Instructional Materials:

MASTER Handout (IMM-P1-HO)
MASTER Laboratory Worksheet (IMM-P1-LW)
MASTER Laboratory Aid (IMM-P1-LA)
MASTER Self-Assessment
Electrical Connection Assortment

References:

Electricity I, Delmar Publishers, Latest Edition
Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-O1 "Principles of Alignment"
IMM-O2 "Methods of Alignment"

Introduction:

Improper electrical connections may cause excessive heat, equipment damage or personal injury.

Presentation Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques

Practical Application:

Student will demonstrate proper installation of electrical connections.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P2) dealing with setting and leveling.

IMM-P1-HO
Install Electrical Connections
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Reading Assignments:

The following chapters are assigned to read from ***Westinghouse Electrical Maintenance Hints,*** Westinghouse Electrical Corporation, publishers, Latest Edition:

Chapters	Title
4	Cable Contraction and Application
41	Insulation Materials

Module Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-P1-LW
Install Electrical Connections
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

2. Student will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

3. Instructor will grade students ability to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

Name:_____ Date:_____

IMM-P1
Install Electrical Connections
Self-Assessment

1. Describe procedure to attachment terminal leads to line leads.

2. What is a butt connector?

3. Describe how a wing nut or a twist connector works.

4. Describe operation of torque wench.

5. Describe procedure for making underground connections.

IMM-P1
Install Electrical Connections
Self-Assessment Answer Key

1 Twisting of bare ends of line leads and terminal leads is done first. Next wire nuts are twisted onto bare twisted leads. Electrical tape is then covered over the wire nuts and make sure that no bare parts are exposed.

2. This connector is used at the end of two wires. The two wires are placed in alignment with bare ends inside one side of the butt connector.

3. Two protruded metal pieces extend out each side of a wire nut. Sometimes the sides of the twist connector are indented to provide a friction surface.

4. A torque wrench is similar to a socket wrench with the added feature of an indicator of pressure applied. This added feature may be a analog or digital dial indicator or it may be a bar mechanism for indicating pressure.

5. Same as Number 1 answer with additional taping to insure a moisture resistant. Kits are available with all supplies necessary to make safe underground connections.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-P2

Subject: Industrial Maintenance **Time: 6 Hrs.**

Duty: Install/Align Machines
Task: Setting and Leveling

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the importance of setting and leveling machinery;
b. Identify shim shapes and locations; and,
c. Demonstrate the procedures for setting and leveling machines.

Instructional Materials:

MASTER Handout (IMM-P2-HO)
MASTER Laboratory Aid (IMM-P2-LA)
MASTER Laboratory Worksheet (IMM-P2-LW)
MASTER Self-Assessment
4 each 1" pillow block bearings
2 each 1" shaves 18" long
1 each coupling
1 each bedplate suitable to mount above on anchor bolts.
Shim pack with necessary shims
Tools and materials to mount project

References:

Mechanics' and Millwrights' Guide (Audel), Nelson, Carla, Macmillan Publishing Company, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-P1 "Install Electrical Connections"

Introduction:

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. In this unit you will understand why and how to mount a machine to it's foundation.

Presentation Outline:

I. Describe the Importance of Setting and Leveling Machinery
   - A. Bedplate
   - B. Foundation

II. Identify Shim Shapes and Locations
   - A. Flat shims
   - B. Wedge-shaped shims
   - C. Check for bedplate distortion

III. Demonstrate the Procedures for Setting and Leveling Machines
   - A. Setting
   - B. Leveling
   - C. Shim thickness

Practical Application:

1. Mount pillow block bearings, shaft and coupling to a suitable bedplate;. and,
2. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P3) dealing with grouting.

IMM-P2-HO
Setting and Leveling
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the importance of setting and leveling machinery;
b. Identify shim shapes and locations; and,
c. Demonstrate the procedures for setting and leveling machines.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance,*** Dick Jeffrey, Delmar/ATP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe the Importance of Setting and Leveling Machinery
   A. Bedplate
   B. Foundation
II. Identify Shim Shapes and Locations
   A. Flat shims
   B. Wedge-shaped shims
   C. Check for bedplate distortion
III. Demonstrate the Procedures for Setting and Leveling Machines
   A. Setting
   B. Leveling

C. Shim thickness

IMM-P2-LA
Setting and Leveling
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount pillow block bearings, shaft and coupling to a suitable bedplate; and,
   c. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.

IMM-P2-LW
Setting and Leveling
Attachment 3: **MASTER** Laboratory Worksheet

Read "Procedure for Setting and Leveling" in the text book.

Name:_____ Date:_____

IMM-P2
Setting and Leveling
Self-Assessment

Circle the letter preceding the most correct answer.

1. The portion of the machine where the driver-driven units are mounted is called the _____.
   a. Foundation
   b. Bedplate
   c. Floor
   d. Setting block

2. One function of the _____ is to absorb machine vibration.
   a. Foundation
   b. Bedplate
   c. Driver motor
   d. Leveling shims

3. To determine the shim thickness to use on leveling a bedplate on small equipment use a/an _____ level.
   a. Angular or grade
   b. Line or string
   c. Surveyors
   d. Engineers or machinist

4. On large equipment or where special accuracy is required use a/an _____ level.
   a. Angular or grade
   b. Line or string
   c. Surveyors
   d. Engineers or machinist

5. Shims should be placed _____.
   a. On 3 inch centers
   b. On top of the bedplate
   c. Midway between the anchor bolts
   d. At the anchor bolt location

6. Wedge shaped shims should be _____.
   a. On 3 inch centers
   b. Midway between the anchor bolts
   c. Stacked causing the top and bottom to be parallel
   d. Driven under the Bedplate edges

7. When the bedplate is pulled down to the foundation to insure no warping has occurred, use a _____ on a driver-driven units.
   a. Dial indicator
   b. Micrometer
   c. Line level
   d. Steel rule

8. If the bedplate is warping, the placement of additional shims is known by loosening the _____ bolts one at a time.
   a. Coupling
   b. Anchor
   c. Drive unit
   d. Drive unit

9. The thickness of the shim pack will depend on the size and weight of the machine, with the minimum being _____ inch.
   a. 1/8
   b. 1/4
   c. 3/4
   d. 1 1/2

10. After the shim thickness is known to make the level read level, the ratio of the length of the level to the length of the _____ must be known to obtain the thickness of the shim at the anchor bolt.
   a. Bedplate
   b. Driver
   c. Driven
   d. Shim

IMM-P2
Setting and Leveling
Self-Assessment Answer Key

1. B
2. A
3. D
4. C
5. D
6. C
7. A
8. B
9. C
10. A

IMM-P3

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-P3

Subject: Industrial Maintenance **Time:** 4 Hrs.

Duty: Install/Align Machines
Task: Grouting

Objective(s):

Upon completion of this module the student will be able to:
a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

Instructional Materials:

MASTER Handout (IMM-P3-HO)
MASTER Laboratory Aid (IMM-P3-LA)
MASTER Laboratory Worksheet (IMM-P3-LW)
MASTER Self-Assessment
Grout
Form Boards
Necessary tools and materials to complete the project

References:

Mechanics' and Millwrights' Guide (Audel), Nelson, Carla, Macmillan Publishing Company, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-P2 "Setting and Leveling"

Introduction:

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. In this unit you will understand how and why grouting is a necessary part of machinery installation.

Presentation Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate
II. Demonstrate Grouting Procedures
   A. Grout dam

Practical Application:

1. Build a dam around the mounted unit in IMM-P2, "Setting and Leveling" practical application section; and,
2. Grout the mounted unit in IMM-P2, "Setting and Leveling" practical outline application section.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P4) dealing with special mountings.

IMM-P3-HO
Grouting
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate
II. Demonstrate Grouting Procedures
   A. Grout dam

IMM-P3-LA
Grouting
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Build a dam around the mounted unit in IMM-P2, "Setting and Leveling" practical application section; and,
   c. Grout mounted unit in IMM-P2, "Setting and Leveling" practical outline application section.

IMM-P3-LW
Grouting
Attachment 3: MASTER Laboratory Worksheet

Review grouting pages of text book.

Name:_____ Date:_____

IMM-P3
Grouting
Self-Assessment

Circle the letter preceding the most correct answer.

1. Grout is a mortar-like concrete which _____ when it sets.
   a. Is rubbery
   b. Soft
   c. Expands
   d. Shrinks

2. The grout secures the _____ and ensures they cannot be dislodged.
   a. Anchor bolts
   b. Shims
   c. Drive unit
   d. Coupling

3. The grout protects the shims form _____.
   a. Corrosion
   b. Paint
   c. Oil
   d. Dust

4. If grout completely fills the _____ it will protect it from corrosion and hazardous liquids.
   a. Foundation
   b. Driver unit
   c. Bedplate
   d. Coupling

5. Grout should be poured at least _____ inches above the shims.
   a. 1/16
   b. 1/8
   c. 3/8
   d. 1

IMM-P3
Grouting
Self-Assessment Answer Key

1. C
2. B
3. A
4. C
5. C

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-P4

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Install/Align Machines
Task: Special Mountings

Objective(s):

Upon completion of this module the student will be able to:
a. Describe adjustable mountains; and,
b. Identify vibration isolators.

Instructional Materials:

MASTER Handout (IMM-P4-HO)
MASTER Laboratory Aid (IMM-P4-LA)
MASTER Laboratory Worksheet (IMM-P4-LW)
MASTER Self-Assessment
Suitable bedplate
A variety of special mountings
Tools and materials to complete the project

References:

Mechanics' and Millwrights' Guide (Audel), Nelson, Carla, Macmillan Publishing Company, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-P3 "Grouting"

Introduction:

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. This unit will describe the reasons and applications for special mounting devices.

Presentation Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance
II. Identify Vibration Isolators
   A. Absorbent materials
   B. Spring mountings

Practical Application:

1. Mount bedplate on adjustable mountings; and,
2. Mount bedplate on vibration isolators.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q1) dealing with using electrical test equipment.

IMM-P4-HO
Special Mountings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe adjustable mountains; and,
b. Identify vibration isolators.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance
II. Identify Vibration Isolators
   A. Absorbent materials
   B. Spring mountings

IMM-P4-LA
Special Mountings
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount bedplate on adjustable mountings; and,
   c. Mount bedplate on vibration isolators.

IMM-P4-LW
Special Mountings
Attachment 3: **MASTER** Laboratory Worksheet

Review the special mountings pages in the textbook.

Name:_____ Date:_____

IMM-P4
Special Mountings
Self-Assessment

Circle the letter preceding the most correct answer.

1. In case of free-standing machines where their positions are frequently changes, anchor bolts may be replaced with _____.
   a. Felt pads
   b. Adjustable mounts
   c. Spring mounts
   d. Wood screws

2. The adjustable mount should be cleaned and greased to insure the _____ will not jam during re-adjustment.
   a. Air line
   b. Bearings
   c. Threads
   d. Coupling

3. A machine using adjustable mountings should have _____.
   a. Flexible service lines
   b. Rigid service lines
   c. Wood bed plates
   d. Secure anchor

4. Machines producing slight vibration, noise and shock should be equipped with special _____.
   a. Wood bed plates
   b. Adjusting mounts
   c. Spring mounts
   d. Absorbent pads

5. Absorbent pads of rubber or felt are sandwiched between two _____ to reduce vibration.
   a. Clay pads
   b. Wood disk
   c. Steel plates
   d. Anchor bolts

6. If vibration is severe and must be absorbed by the mountings a _____ should be used.
   a. Spring mount
   b. Rubber pad
   c. Felt pad
   d. Adjustable mount

IMM-P4
Special Mountings
Self-Assessment Answer Key

1. B
2. C
3. A
4. D
5. C
6. A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-Q1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-Q1

Subject: Industrial Maintenance **Time: 20 Hrs.**

Duty: Maintain Electrical Devices
Task: Use Electrical Test Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Instructional Materials:

MASTER Handout (IMM-Q1-HO)
MASTER Laboratory Worksheet (IMM-Q1-LW)
MASTER Laboratory Aid (IMM-Q1-LA)
MASTER Self-Assessment
VOM-Analog
VOM-Digital

References:

Basic Electronics, Bernard Grob, McGraw-Hill Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6 "Practice Safety" series
IMM-P4 "Special Mountings"

Introduction:

Working safely should be the concern of every individual. Safety includes protecting yourself and others from injury. While others - your employer, your family, governmental agencies, and insurance companies - are concerned for your well-being, you have the final responsibility for your safety in the workplace. Being aware of your surrounding and selecting and using correct safety equipment is your responsibility.

Presentation Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement

Practical Application:

1. Instructor will demonstrate selection and proper use of electrical test equipment.
2. Students will be allowed to practice the use of electrical test equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q2) dealing with application of basic terms to electrical circuits.

IMM-Q1-HO
Use Electrical Test Equipment
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Reading Assignments:

The following chapters are assigned to read from *Electricity I,* Kubala, Delmar Publishing, Latest Edition:

Chapter	Title
6	Circuits

Module Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement

IMM-Q1-LA
Use Electrical Test Equipment
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q1-LW
Use Electrical Test Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice performing.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

2. Instructor will grade student's performance on.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

Name:_____ Date:_____

IMM-Q1
Use Electrical Test Equipment
Self-Assessment

1. Describe how to use an analog multimeter to measure DC voltage.

2. Describe how to use an analog multimeter to measure AC voltage.

3. Describe how to use an analog multimeter to measure DC current.

4. Describe how to use an analog multimeter to measure resistant.

5. Describe how to use a digital multimeter to measure DC voltage.

6. **Describe how to use a digital multimeter to measure AC voltage.**

7. **Describe how to use a digital multimeter to measure DC current.**

8. **Describe how to use a digital multimeter to measure resistant.**

IMM-Q1
Use Electrical Test Equipment
Self-Assessment Answer Key

1. Move range switch to highest DC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change scale to next lower scale. This process can be repeated until the needle moves to highest reading without going off scale.

2. Same procedure as question 1 except use AC voltage scale instead of DC voltage scale. Move range switch to highest AC voltage scale. Plug red lead into positive lead on the multimeter. Plug black lead into the negative terminal on the multimeter. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from AC voltage and change scale to next lower scale. This process can be repeated until the needle moves to highest reading without going off scale.

3. Use same procedure as question 1 with two exceptions; use DC current scales instead of DC voltage scales and make sure the lead connections are made so that the multimeter is placed in series with the load instead of parallel with the load.

4. Move range switch to highest DC ohmic scale. Plug red lead into positive lead on the multimeter. Plug black lead into the negative terminal on the multimeter. Measure resistance. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from source and change scale to next lower scale. This process can be repeated until needle moves to highest reading without going off scale.

5. Same procedure as question 1 for the analog multimeter except reading is a digital number instead of a needle movement. Some digital multi meters may have autorange capability. Move range switch to highest DC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change the scale to the next lower scale. This process can be repeated until the digital number moves to highest reading without going off scale.

6. Same procedure as question 2 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest AC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from AC voltage

and change scale to next lower scale. This process can be repeated until the digital number moves to the highest reading without going off scale.

7. Same procedure as question 3 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest DC current scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure current. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC current source and change scale to next lower scale. This process can be repeated until the digital number indicates the highest reading without going off scale.

8. Same procedure as question 4 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest ohmic scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure ohms. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change scale to next lower scale. This process can be repeated until the digital number moves to the highest reading without going off scale.

IMM-Q2

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-Q2

Subject: **Industrial Maintenance** **Time: 10 Hrs.**

Duty: **Maintain Electrical Devices**
Task: Apply Basic Terms to Electrical Circuits

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
g. Amperage (current);
i. Closed circuit;
j. Open circuit;
k. Sources of electricity;
l. Ohm's Law; and,
m. Power.

Instructional Materials:

MASTER Handout (IMM-Q2-HO)
MASTER Self-Assessment
Classroom
Chalkboard
Overhead

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition

Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-Q1 "Use Electrical Test Equipment"

Introduction:

In order to understand electricity, a basic understanding of electrical terms is essential.

Presentation Outline:

I. Polarity
II. Electron
III. Proton
IV. Neutrons
V. Coulomb
VI. Atom
VII. Voltage (Potential Difference)
VIII. Resistance
IX. Amperage (Current)
X. Closed Circuit
XI. Open Circuit
XII. Sources of Electricity
XIII. Ohm's Law
XIV. Power

Practical Application:

Student will use knowledge to build information practical circuit application in next technical module.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q3) dealing with analyzing series, parallel and complex AC/DC circuits.

IMM-Q2-HO
Apply Basic Terms to Electrical Circuits
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
g. Amperage (current);
i. Closed circuit;
j. Open circuit;
k. Sources of electricity;
l. Ohm's Law; and,
m. Power.

Reading Assignments:

The following chapters are assigned to read from *Basic Electronics*, Bernard Grab, McGraw-Hill Publishers, Latest Edition

Chapters	Title
1	Survey of Electronics
2	Electricity
3	Ohm's Law

Module Outline:

I. Polarity
II. Electron
III. Proton
IV. Neutrons
V. Coulomb
VI. Atom
VII. Voltage (Potential Difference)
VIII. Resistance
IX. Amperage (Current)
X. Closed Circuit
XI. Open Circuit
XII. Sources of Electricity
XIII. Ohm's Law
XIV. Power

Name:_____ Date:_____

IMM-Q2
Apply Basic Terms to Electrical Circuits
Self-Assessment

1. The _____ is the basic circuit of negative charge.

2. A _____ hrs. The same amount of charges as the neutron.

3. _____ polarity is used with the electron.

4. All matter has electricity in the form of _____ in the _____.

5. Potential difference can be exposed as _____.

6. Define open circuit.
_____
_____
_____

7. Define closed circuit.
_____
_____
_____

8. _____ is a measure of the quantity of stored charge.

9. An _____ is the measure of resistance.

10. A _____ has no charge.

11. Define Ohm's Law.
_____
_____
_____

12. Define power (formula).
_____
_____
_____

IMM-Q2
Apply Basic Terms to Electrical Circuits
Self-Assessment Answer Key

1. Electron
2. mp
3. Negative
4. Charges, atom
5. Voltage
6. The circuit is not complete or closed, therefore, no current can flow in this circuit.
7. A complete closed circuit is one that current flows when a voltage source is present.
8. Coulomb
9. Ohm
10. Neutron
11. $E = I \times R$
12. $P = E \times I$

IMM-Q3

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-Q3

Subject: **Industrial Maintenance** **Time: 24 Hrs.**

Duty: **Maintain Electrical Devices**
Task: Analyze Series, Parallel, and Complex AC/DC Circuits

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Instructional Materials:

MASTER Handout (IMM-Q3-HO)
MASTER Laboratory Aid (IMM-Q3-LA)
MASTER Laboratory Worksheet (IMM-Q3-LW)
MASTER Self-Assessment
Resistors
Series Circuit
Parallel Circuit
Series-Parallel Circuit
Inductors
DC Source
AC Single Phase Source

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition

Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-Q2 "Apply Basic Terms to Electrical Circuits"

Introduction:

Electrical circuits are fundamental to all electrical devices and controls.

Presentation Outline:

I. Series Circuits
II. Parallel Circuits
III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters

Practical Application:

Student will calculate and construct:
a. Series circuits
b. Parallel circuits
c. Series-parallel circuits
d. Voltage dividers
e. DC meters
f. AC circuits
g. AC meters

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q4) dealing with checking AC/DC motors.

IMM-Q3-HO
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Reading Assignments:

The following chapters are assigned to read from *Electrical Circuits*, Bernard Grob, McGraw-Hill Publishers, Latest Edition

Chapters	Title
3	Series Circuits
4	Parallel Circuits
5	Series-Parallel Circuits
7	Voltage Dividers
8	DC Meters

Module Outline:

I. Series Circuits
II. Parallel Circuits

III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters

IMM-Q3-LA
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q3-LW
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 3: **MASTER** Laboratory Worksheet

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1. The student will practice:
   a. Calculating series circuit;
   b. Constructing series circuit safely;
   c. Calculating parallel circuit;
   d. Constructing parallel circuit safely;
   e. Calculating series-parallel circuit;
   f. Constructing series-parallel circuit safely;
   g. Calculating AC single phase circuit; and,
   h. Constructing AC single phase circuit.

2. Instructor will grade student's performance.

Name:_____ Date:_____

IMM-Q3
Analyze Series, Parallel, and Complex AC/DC Circuits
Self-Assessment

Circle the letter preceding the most correct answer.

1. A circuit with two or more current paths is a/an _____ circuit.
   A. series
   B. parallel
   C. open
   D. compound

2. A loose or dirty electrical connection will produce _____:
   A. excess heat at the connection.
   B. a lot of noise on start up.
   C. chatter until circuit warms up.
   D. excess voltage and damage to the unit.

3. A closed electrical circuit is one where _____:
   A. fewer electrons can flow because of the closure.
   B. the path for current flow is complete.
   C. there is more than one load in the circuit.
   D. the switch is in the open position.

4. A circuit that has only one path for current flow is a/an _____ circuit.
   A. series
   B. parallel
   C. series-parallel
   D. none of the above

5. In a series circuit the current in the circuit _____:
   A. is the same anywhere in the circuit.
   B. is divided between the total resistors in the circuit.
   C. is not dependent upon the total voltage applied to the circuit.
   D. is not related to the electron (charge) flow rate

6. In a parallel circuit the total resistance is _____:
   A. smaller than the smallest branch resistance.
   B. the sum of all the resistors in all branches.
   C. dependent upon the number of branches in the circuit.
   D. all the above.

7. In a series-parallel circuit the voltage drop across the series resistor _____:
   A. will always be larger than the branch voltage drops.
   B. will not effect the total current in the circuit.
   C. will determine the total resistance in the branches.
   D. will determine the voltage drop across the other branches.

8. The algebraic sum of the source voltage and the voltage drops in any closed circuit _____:
   A. is equal to the sum of the voltage drops across each resistor.
   B. is dependent upon the source voltage.
   C. is equal to zero.
   D. none of the above

9. An electrical circuit in which voltage is equally applied to every load is known as a _____ circuit.
   A. series
   B. parallel
   C. series-parallel
   D. reactive

10. Current is directly proportional to voltage and inversely proportional to resistance. Therefore when _____:
   A. resistance is increased, current will be decreased.
   B. resistance is increased, current will be increased.
   C. resistance is decreased, current will be decreased.
   D. resistance is decreased, current will not change.

11. Current is directly proportional to voltage and inversely proportional to resistance. Therefore when _____:
   A. voltage is increased, current will be decreased.
   B. voltage is increased, current will be increased.
   C. voltage is decreased, current will be increased.
   D. voltage is decreased, current will not change.

12. The considered standard frequency of AC power in the United States is _____ Hertz.
   A. 400
   B. 120
   C. 60
   D. 50

13. The effective value of AC voltage and current is also known as what value?

_____

A. RMS
B. Peak-to-Peak
C. Equivalent
D. Average

14. The current in an inductive circuit is caused to _____:

A. lag the voltage.
B. lead the voltage.
C. oppose the voltage.
D. be in phase with the voltage.

15. If AC is applied to resistance in a normally DC circuit _____:

A. Ohm's Law calculations do not apply.
B. rules for series and parallel circuits do not apply.
C. Ohm's Law and rules for series and parallel circuits do apply.
D. Ohm's Law and rules for series circuits **only** do apply.

16. Amplitude of an AC voltage or current sine wave is the _____ of the wave.

A. effective value
B. peak value
C. wavelength value
D. frequency value

IMM-Q3
Analyze Series, Parallel, and Complex AC/DC Circuits
Self-Assessment Answer Key

1. B
2. A
3. B
4. A
5. A
6. A
7. D
8. C
9. B
10. A
11. B
12. C
13. A
14. A
15. C
16. B

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-Q4

Subject: Industrial Maintenance **Time: 40 Hrs.**

Duty: Maintain Electrical Devices
Task: Check AC and DC Motors

Objective(s):

Upon completion of this module the student will be able to install, maintain and troubleshoot:

a. Capacitor motors;
b. Repulsion motors;
c. Three phase motors;
d. Direct current motors;
e. Universal motors;
f. Shaded pole motors;
g. Generator; and,
h. Alternator.

Instructional Materials:

MASTER Handout (IMM-Q4-HO)
MASTER Laboratory Worksheet (IMM-Q4-LW)
MASTER Laboratory Aid (IMM-Q4-LA)
MASTER Self-Assessment
Capacitor motors
Repulsion motors
Three phase motors
Direct current motors
Universal motors
Shaded pole motors
Generator
Alternator

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition

Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-Q3 "Analyze Series, Parallel, and Complex DC/AC Circuits"

Introduction:

Motors perform many useful functions and activities for an industrial maintenance mechanic. Motors turns pumps, fans, compressors, and create rotational mechanical motion.

Presentation Outline:

I. Capacitor Motors
II. Repulsion Motors
III. Three Phase Motors
IV. Direct Current Motors
V. Universal Motors
VI. Shaded Pole Motors
VII. Generator
VIII. Alternator

Practical Application:

Student will check the following motors in a lab setting:
a. Capacitor motors;
b. Repulsion motors;
c. Three phase motors;
d. Direct current motors;
e. Universal motors;
f. Shaded pole motors;
g. Generator; and,
h. Alternator.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q5) dealing with troubleshooting electrical devices.

IMM-Q4-HO
Check AC and DC Motors
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to install, maintain and troubleshoot:

a. Capacitor motors;
b. Repulsion motors;
c. Three phase motors;
d. Direct current motors;
e. Universal motors;
f. Shaded pole motors;
g. Generator; and,
h. Alternator.

Reading Assignments:

The following chapters are assigned to read from ***Electrical Motors***, by Audel Publishing, Latest Edition: Use entire book as a reading assignment.

Module Outline:

I. Capacitor Motors
II. Repulsion Motors
III. Three Phase Motors
IV. Direct Current Motors
V. Universal Motors
VI. Shaded Pole Motors
VII. Generator
VIII. Alternator

IMM-Q4-LA
Check AC and DC Motors
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q4-LW
Check AC and DC Motors
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice installing, maintaining and troubleshooting the following motors:
   a. Capacitor motors;
   b. Repulsion motors;
   c. Three phase motors;
   d. Direct current motors;
   e. Universal motors;
   f. Shaded pole motors;
   g. Generator; and,
   h. Alternator.

2. Instructor will grade performance of student.

Name:_____ Date:_____

IMM-Q4
Check AC and DC Motors
Self-Assessment

Draw the symbols for:

1 Capacitor Motors _____

2. Repulsion Motors _____

3. Three Phase Motors _____

4. Direct Current Motors _____

5. Universal Motors _____

6. Shaded Pole Motors _____

7. Generator _____

8. Alternator _____

Briefly explain operation of:

1 Capacitor Motors

_____
_____
_____

2. Repulsion Motors

_____
_____
_____

3. Three Phase Motors

_____
_____
_____

4. Direct Current Motors

5. Universal Motors

6. Shaded Pole Motors

7. Generator

8. Alternator

IMM-Q5

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-Q5

Subject: **Industrial Maintenance** **Time: 10 Hrs.**

Duty: **Maintain Electrical Devices**
Task: Troubleshoot Electrical Devices

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:

a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Instructional Materials:

MASTER Handout (IMM-Q5-HO)
MASTER Laboratory Aid (IMM-Q5-LA)
MASTER Laboratory Worksheet (IMM-Q5-LW)
MASTER Self-Assessment
Resistor
Capacitors
Inductors
Motors
Relays

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-Q4 "Check AC and DC Motors"

Introduction:

Troubleshooting is the skill of solving an electrical problem and fixing the problem. This skill is in high demand today.

Presentation Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays

Practical Application:

Student will practice troubleshooting electrical devices.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (IMM-R1) dealing with force.

IMM-Q5-HO
Troubleshoot Electrical Devices
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:

a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Reading Assignments:

The following chapters are assigned to read from ***Basic Electronics***, Grob, McGraw-Hill Publishers, Latest Edition:

Chapters	Title
17	Capacitance
20	Inductance

Module Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays

IMM-Q5-LA
Troubleshoot Electrical Devices
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q5-LW
Troubleshoot Electrical Devices
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice troubleshooting:
   a. Resistors;
   b. Capacitors;
   c. Inductors;
   d. Motors; and,
   e. Relays.

2. Instructor will grade students performance.

Name:_____ Date:_____

IMM-Q5
Troubleshoot Electrical Devices
Self-Assessment

1. Define troubleshooting.

2. List logical steps to troubleshooting an electrical service.

3. What does a resistor do in an electrical circuit?

4. Define capacitance.

5. Define inductance.

6. What is the normal function for a relay?

7. List major types of DC, single phase AC and three phase motors.

IMM-Q5
Troubleshoot Electrical Devices
Self-Assessment Answer Key

1. To search for the cause of a malfunction.

2. Isolate or sectionalize problem

3. Reduce current flow.

4. Increase power factor, ability of a dielectric to store electric charge, opposite to inductance characteristic.

5. Ability of a conductor to produce induced voltage when current varies.

6. At least one coil and one contact. Allows a small voltage source to control a larger voltage load.

7. DC: series, parallel and compound.
   AC: single phase: capacitor, repulsion, split phase, shaded pole, and universal.
   AC: three phase: squirrel cage induction, synchronous and wound rotor.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks													
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout								
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations								
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions											
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools												
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools												
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press								
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering											
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems					
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches										
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together											

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-R1

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-R1

Subject: Industrial Maintenance **Time: 2 Hrs.**

Duty: Basic Mechanical Concepts
Task: Force

Objective(s):

Upon completion of this module the student will be able to:

a. Define force;
b. Describe linear force;
c. Describe rotational force;
d. Calculate linear force; and,
e. Calculate rotational force.

Instructional Materials:

MASTER Handout (IMM-R1-HO)
MASTER Self-Assessment
Classroom
Overhead Projector
Chalkboard

References:

Energy For Man, Thirring, Hans, Greenwood Press, Latest Edition
Power-Prime Mover of Technology, Duffy, Joseph, McKnight and McKnight Publishers, Latest Edition
Energy, Wilson, Mitchell, Life Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-Q5 "Troubleshoot Electrical Devices"

Introduction:

Force may cause motion. Force may change equilibrium. Forces alter many areas of an industrial maintenance mechanic's job.

Presentation Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force

Practical Application:

Student will relate how force can affect motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R2) dealing with work.

IMM-R1-HO
Force
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define force;
b. Describe linear force;
c. Describe rotational force;
d. Calculate linear force; and,
e. Calculate rotational force.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science,* James T. Shipman, D.C. Heath Publishers, Latest Edition:

Chapters	Title
3	Force and Motion

Module Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force

Name:_____ Date:_____

IMM-R1
Force
Self-Assessment

1. Define Force.

_____
_____
_____

2. List basic types of forces.

_____
_____
_____

IMM-R1
Force
Self-Assessment Answer Key

1 A mechanical force is a push or a pull.

2. Concurrent, parallel in the same direction, parallel in the opposite direction and collinear, balanced and unbalanced.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-R2

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Basic Mechanical Concepts
Task: Work

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Instructional Materials:

MASTER Handout (IMM-R2-HO)
MASTER Self-Assessment
Chalkboard

References:

Energy For Man. Thirring, Hans, Greenwood Press, Latest Edition
Power-Prime Mover of Technology, Duffy, Joseph, McKnight and McKnight Publishers, Latest Edition
Energy, Wilson, Mitchell, Life Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R1 "Force"

Introduction:

Work is useable energy. This is a useful term.

Presentation Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency

Practical Application:

Student will reflect how work is related to motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R3) dealing with mechanical motion and rate.

IMM-R2-HO
Work
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, DC Heath Publishes, Latest Edition:

Chapters	Title
4	Work and Energy

Module Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency

Name:_____ Date:_____

IMM-R2
Work
Self-Assessment

1. Define work.

_____
_____
_____

2. Define kinetic energy.

_____
_____
_____

3. Define potential energy.

_____
_____
_____

4. List four forms of energy.

_____
_____
_____

5. State Law of Conservation of Energy.

_____
_____
_____

IMM-R2
Work
Self-Assessment Answer Key

1. Work happens when a force causes an object to move.

2. Energy relating to dynamic motion. Bodies in motion.

3. Energy relating to the position or height above a place to which an object may fall. Bodies at rest.

4. Electrical, mechanical, chemical, thermal, radiant or vibrational. (Pick 4)

5. Sometimes energy may change forms, but it is conserved.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-R3

Subject: Industrial Maintenance **Time: 3 Hrs.**

Duty: Basic Mechanical Concepts
Task: Mechanical Motion and Rate

Objective(s):

Upon completion of this module the student will be able to:
a. Define motion;
b. Define rate; and,
c. Compare motion to rate.

Instructional Materials:

MASTER Handout (IMM-R3-HO)
MASTER Laboratory Aid (IMM-R3-LA)
MASTER Laboratory Worksheet (IMM-R3-LW)
MASTER Self-Assessment
Chalkboard
Chalk

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al., John Wiley & Sons Publishers, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R2 "Work"

Introduction:

Mechanical motion causes devices, people, materials, and parts to change. Location a fundamental understanding of how this happens is important. This technical module deals with a study of mechanical motion and rate.

Presentation Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate

Practical Application:

1. Demonstrate mechanical motion; and,
2. Demonstrate how a different rate effects speeds.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R4) dealing with simple machines.

IMM-R3-HO
Mechanical Motion and Rate
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define motion;
b. Define rate; and,
c. Compare motion to rate.

Reading Assignments:

The following chapters are assigned to read from ***Mechanism Analysis***, Barton, Dekker Publishers, Latest Edition:

Chapter	Title
1	Types of Motion

Module Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate

IMM-R3-LA
Mechanical Motion and Rate
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate mechanical motion; and,
   c. Demonstrate how a different rate effects speeds.

IMM-R3-LW
Mechanical Motion and Rate
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will design a series of experiments to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

2. Student will be graded on his/her ability to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

Name:_____ Date:_____

IMM-R3
Mechanical Motion and Rate
Self-Assessment

1. Define motion.

_____
_____
_____

2. Define rate.

_____
_____
_____

3. Compare motion to rate.

_____
_____
_____

IMM-R3
Mechanical Motion and Rate
Self-Assessment Answer Key

1. **Movement, process of changing place.**

2. **Speed of motion.**

3. **Motion is movement, rate is the speed of movement.**

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-R4

Subject: Industrial Maintenance **Time: 9 Hrs.**

Duty: Basic Mechanical Concepts
Task: Simple Machines

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Instructional Materials:

MASTER Handout (IMM-R4-HO)
MASTER Laboratory Worksheet (IMM-R4-LW)
MASTER Laboratory Aid (IMM-R4-LA)
MASTER Self-Assessment
Chalkboard
Overhead
Classroom

References:

Mechanics' and Millwrights' Guide, Audel Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R3 "Mechanical Motion and Rate"

Introduction:

Machines play an integral part of the daily operation of an industrial plant. Machines to be stretched, merged, tossed, cut, heated, and etc.

Presentation Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines

Practical Application:

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R5) dealing with power.

IMM-R4-HO
Simple Machines
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Reading Assignments:

The following chapters are assigned to read from *Industrial Trades Handbook,* Basarnba, IPT Publishers, Latest Edition

Chapters	Title
6	Pulleys

Module Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-R4-LW
Simple Machines
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Calculate force;
   b. Properly install and adjust levers;
   c. Properly use wedges;
   d. Properly adjust cams; and,
   e. Properly install and adjust pulleys.

2. Student will be graded on:
   a. Calculating force;
   b. Properly installing and adjusting levers;
   c. Properly using wedges;
   d. Properly adjusting cams; and,
   e. Properly installing and adjusting pulleys.

Name:_____ Date:_____

IMM-R4
Simple Machines
Self-Assessment

1. The force acting on lever (6" long) with an acceleration of 6 ft/min is _____.

2. Define pulley.
_____
_____
_____

3. Define lever.
_____
_____
_____

4. Define cam.
_____
_____
_____

IMM-R4
Simple Machines
Self-Assessment Answer Key

1. Force = 1/2 ft. times 6 ft./min. = 3 ft. sq./min.

2. A sheave or wheel with a grooved rim in which a rope or belt is placed in to cause mechanical motion.

3. A rigid piece that transmits motion when force is applied to a point on the lever.

4. A rotating or sliding piece in a mechanical linkage used to transmit rotating motion into linear motion or vice versa.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-R5

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Basic Mechanical Concepts
Task: Power

Objective(s):

Upon completion of this module the student will be able to:

a. Define power;
b. Compare power to work;
c. Define mechanical power; and,
d. Compare mechanical power to electrical power.

Instructional Materials:

MASTER Handout (IMM-R5-HO)
MASTER Self-Assessment
Chalkboard
Overhead
Classroom

References:

Energy For Man, Thirring, Hans, Greenwood Press, Latest Edition
Power-Prime Mover of Technology, Duffy, Joseph, McKnight and McKnight Publishers, Latest Edition
Energy, Wilson, Mitchell, Life Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R4 "Simple Machines"

Introduction:

Power is a very important term to a maintenance mechanic. Power creates motion. Mechanical motion is the prime mover. Power also creates heat.

Presentation Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power

Practical Application:

Student will relate how power effects mechanical motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S1) dealing with fasteners and nomenclature.

IMM-R5-HO
Power
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define power;
b. Compare power to work;
c. Define mechanical power; and,
d. Compare mechanical power to electrical power.

Reading Assignments:

The following chapters are assigned to read from ***Introduction to Physical Science,*** James Shipman, D. C. Heath Co. Publishers, Latest Edition

Chapter	Title
4.2	Power

Module Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power

Name:_____ Date:_____

IMM-R5
Power
Self-Assessment

1. Define power.

2. Compare work to power.

3. Define mechanical power.

4. Compare electrical power to mechanical power.

IMM-R5
Power
Self-Assessment Answer Key

1. Power is the rate of doing work.

2. Work does not depend on speed or time. However, power does depend on time. Power is a measure of how fast or slow work is done.

3. The power formula for mechanical is (P = F x V). Power is found by two methods. In the first method, work is determined. Then the value of work is divided by time, giving power (P = W/T). In the second method, power is found directly from the product of force and speed (P = F x V). The conversion from ft-lb/sec to horsepower (HP) is then calculated.

4. The power formula for electrical is (P = W/T). The power formula for mechanical is (P = F x V).

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
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E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S1

Subject: Industrial Maintenance **Time: 11 Hrs.**

Duty: Fasteners and Preloading
Task: Fasteners and Nomenclature

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Instructional Materials:

MASTER Handout (IMM-S1-HO)
MASTER Laboratory Aid (IMM-S1-LA)
MASTER Laboratory Worksheet (IMM-S1-LW)
MASTER Self-Assessment
Assortment of fasteners including bolts, screws, pins and rivets
Internal retain ring pliers
External retain ring pliers
Screwdrivers: straight and phillips
Wrench-torque: open and box end
Rivet gun
Ball peen hammer

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition

Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R5 "Power"

Introduction:

Parts are held together with fasteners.

Presentation Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine
IV. Nuts
  A. Machine screw
  B. Jam
V. Washers
  A. Plain
  B. Lock
  C. Pre-assembled screw and washer
VI. Pins
  A. Cotter
  B. Tapered
VII. Keys
  A. Square
  B. Gib
  C. Woodruff
VIII. Retaining Ring
  A. Internal
  B. External
IX. Rivets
  A. Head
  B. Size
  C. Length
  D. Tinner
  E. Material

F. Tubular
G. Blind

X. How to Specify Fasteners
A. Name
B. Quanity
C. Kind
D. Size
E. Shape
F. Catalog

Practical Application:

1. Identify all fasteners displayed in lab; and,
2. Identify all tools displayed in lab.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S2) dealing with applications for various fasteners.

IMM-S1-HO
Fasteners and Nomenclature
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from *Metal Work*, Cupples, Glencoe Publishers, Latest Edition

Chapter	Title
26	Fasteners

Module Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine

IV. Nuts
   A. Machine screw
   B. Jam
V. Washers
   A. Plain
   B. Lock
   C. Pre-assembled screw and washer
VI. Pins
   A. Cotter
   B. Tapered
VII. Keys
   A. Square
   B. Gib
   C. Woodruff
VIII. Retaining Ring
   A. Internal
   B. External
IX. Rivets
   A. Head
   B. Size
   C. Length
   D. Tinner
   E. Material
   F. Tubular
   G. Blind
X. How to Specify Fasteners
   A. Name
   B. Quanity
   C. Kind
   D. Size
   E. Shape
   F. Catalog

IMM-S1-LA
Fasteners and Nomenclature
Attachment 2: MASTER Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Identify all fasteners displayed in lab; and,
   c. Identify all tools displayed in lab.

IMM-S1-LW
Fasteners and Nomenclature
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

Name:_____ Date:_____

IMM-S1
Fasteners and Nomenclature
Self-Assessment

Circle the letter preceding the most correct answer.

1. When measuring length of a screw, this screw includes measuring the head also:
   a. Machine
   b. Wood
   c. Lag
   d. Flat head

2. This fastener is used to fasten wooden parts to metal:
   a. Stove
   b. Carriage
   c. Stud
   d. All of these

3. The screw is threaded like a wood screw, used to fastened machines to wooden floors.
   a. Machine
   b. Wood
   c. Lag
   d. Flat head

4. This fastener locks in another, prevents loosening by vibration.
   a. Jam
   b. Machine screw
   c. Castle
   d. Wing

5. This pin is used to slip through a hole in bolt and opening in castle nut to prevent turning:
   a. Tapered
   b. Roll
   c. Cotter
   d. All of these

6. This type of retaining pin is driven into place:
   a. Self-locking
   b. Internal
   c. External
   d. All of these

IMM-S1
Fasteners and Nomenclature
Self-Assessment Answer Key

1. D
2. B
3. C
4. A
5. C
6. A

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S2

Subject: Industrial Maintenance **Time: 12 Hrs.**

Duty: Fasteners and Preloading
Task: Application for Various Fasteners

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Instructional Materials:

MASTER Handout (IMM-S2-HO)
MASTER Laboratory Aid (IMM-S2-LA)
MASTER Laboratory Worksheet (IMM-S2-LW)
MASTER Self-Assessment
Assortment of fasteners including bolts, screws, pins and rivets
Internal retain ring pliers
External retain ring pliers
Screwdrivers: straight and phillips
Wrench-torque: open and box end
Rivet gun
Ball peen hammer

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition

Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S1 "Fasteners and Nomenclature"

Introduction:

Parts are held together with fasteners.

Presentation Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine
IV. Nuts
  A. Machine screw
  B. Jam
V. Washers
  A. Plain
  B. Lock
  C. Pre-assemble screw and washer
VI. Pins
  A. Cotter
  B. Tapered
VII. Keys
  A. Square
  B. Gib
  C. Woodruff
VIII. Retaining Ring
  A. Internal
  B. External
IX. Rivets
  A. Head
  B. Size
  C. Length
  D. Tinner
  E. Material

F. Tubular
G. Blind

X. How to Specify Fasteners
A. Name
B. Quantity
C. Kind
D. Size
E. Shape
F. Catalog

Practical Application:

Student will demonstrate how to specify fasteners.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S3) dealing with techniques for removing damaged fasteners.

IMM-S2-HO
Application for Various Fasteners
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work,*** Cupples, Glencoe Publishers, Latest Edition:

Chapter	**Title**
26	Fasteners

Module Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine

IV. Nuts
   A. Machine screw
   B. Jam
V. Washers
   A. Plain
   B. Lock
   C. Pre-assemble screw and washer
VI. Pins
   A. Cotter
   B. Tapered
VII. Keys
   A. Square
   B. Gib
   C. Woodruff
VIII. Retaining Ring
   A. Internal
   B. External
IX. Rivets
   A. Head
   B. Size
   C. Length
   D. Tinner
   E. Material
   F. Tubular
   G. Blind
X. How to Specify Fasteners
   A. Name
   B. Quantity
   C. Kind
   D. Size
   E. Shape
   F. Catalog

IMM-S2-LA
Application for Various Fasteners
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to specify fasteners.

IMM-S2-LW
Application for Various Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

Name:_____ Date:_____

IMM-S2
Application for Various Fasteners
Self-Assessment

1. What are carriage bolts used for?

_____
_____
_____

Stove bolts?

_____
_____
_____

Stud bolts?

_____
_____
_____

2. Name two types of setscrews and give an example of how each is used.

_____
_____
_____

3. Describe a lag screw. What is it used for?

_____
_____
_____

4. Describe a thumbscrew. What is it used for?

_____
_____
_____

5. What is a jam nut used for?

_____
_____
_____

6. What is a castles nut used for?

_____
_____
_____

7. How is a cotter pin used?

8. How are taper pins used?

9. What are retaining rings, and how are they used?

10. List two types of self-threading screws. How are they used?

IMM-S2
Application for Various Fasteners
Self-Assessment Answer Key

1. Carriage bolts: fasten wooden parts to metal
   Stove bolts: general purpose- no precision fit
   Stud bolts: inserted into metal parts needed to project bolts to fasten to other parts.

2. Square head used to fasten pulleys and collars on shafts; headless used as a safety device on moving parts.

3. Threaded like wood screws with square or hex head; fasten machines to wooden floors.

4. One or more wings; used for hand tightening.

5. Locks into another nut; reduce vibrations.

6. Locked to bolt with cotter key; wheel bearings.

7. Slip through hole in bolt and castle nut to prevent turning.

8. Fit into taper hole in joining parts; fasten parts together.

9. Seated in internal or external grooves to lock in position.

10. Cut threads or form threads; divine into holes slightly larger than diameter of screws.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S3

Subject: **Industrial Maintenance** **Time: 3 Hrs.**

Duty: **Fasteners and Preloading**
Task: Techniques for Removing Damaged Fasteners

Objective(s):

Upon completion of this module the student will be able to use screw extractors to remove a broken bolt.

Instructional Materials:

MASTER Handout (IMM-S3-HO)
MASTER Laboratory Aid (IMM-S3-LA)
MASTER Laboratory Worksheet (IMM-S3-LW)
Sealed extractor
Diamond point chisel
Tap wrench
Broken Bolt
Power Drill
Drill bit for use with broken bolt

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S2 "Application for Various Fasteners"

Introduction:

A broken bolt or screw can be removed from a hole. If the bolt or screw is not made of hardened steel, this procedure is possible. This module deals with the procedure to remove a broken bolt.

Presentation Outline:

I. Screw Extractor Components
   - A. Screw extractor
   - B. Tap wrench

II. Procedure for Removing a Broken Bolt
   - A. Use hand drill
   - B. Deduct drill bit
   - C. Secure drill bit in hand drill
   - D. Drill hole in broken bolt
   - E. Place tap wrench onto screw extractor
   - F. Turn screw extractor counter clock wise
   - G. When force to firm, stop turning and pull extract out, plus broken bolt

Practical Application:

1. Student will use screw extractor to remove broken bolt; and,
2. Student will use diamond point chisel to remove broken bolt.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S4) dealing with cleaning and restoring threaded fasteners.

IMM-S3-HO
Techniques for Removing Damaged Fasteners
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to use screw extractors to remove a broken bolt.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work***, Cupples, Glencoe Publishers, Latest Edition:

Chapter	Title
25	Fasteners

Module Outline:

I. Screw Extractor Components
   A. Screw extractor
   B. Tap wrench
II. Procedure for Removing a Broken Bolt
   A. Use hand drill
   B. Deduct drill bit
   C. Secure drill bit in hand drill
   D. Drill hole in broken bolt
   E. Place tap wrench onto screw extractor
   F. Turn screw extractor counter clock wise
   G. When force to firm, stop turning and pull extract out, plus broken bolt

IMM-S3-LA
Techniques for Removing Damaged Fasteners
Attachment 2: MASTER Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will use screw extractor to remove broken bolt; and,
   c. Student will use diamond point chisel to remove broken bolt.

IMM-S3-LW
Techniques for Removing Damaged Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to use screw extractors to remove a broken bolt.

2. Student will demonstrate how to use screw extractors to remove a broken bolt.

3. Instructor will grade student's ability to use screw extractors to remove a broken bolt.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER TECHNICAL MODULE NO. IMM-S4

Subject: Industrial Maintenance **Time: 3 Hrs.**

Duty: Fasteners and Preloading
Task: Cleaning and Restoring Threaded Fasteners

Objective(s):

Upon completion of this module the student will be able to:
a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Instructional Materials:

MASTER Handout (IMM-S4-HO)
MASTER Laboratory Aid (IMM-S4-LA)
MASTER Laboratory Worksheet (IMM-S4-LW)

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S3 "Techniques for Removing Damaged Fasteners"

Introduction:

Housekeeping is important. Housekeeping of fasteners is also important to make parts mate properly. Sometimes threads may become cross threaded and may require rethreading in order to mate properly.

Presentation Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth
II. Restoring Threads

Practical Application:

1. Student will demonstrate how to clean threaded fasteners; and,
2. Student will demonstrate how to restore threaded fasteners.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S5) dealing with torque/preload theory.

IMM-S4-HO
Cleaning and Restoring Threaded Fasteners
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work***, Cupples, Glencoe Publishers, Latest Edition:

Chapter	Title
15	Fasteners

Module Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth
II. Restoring Threads

IMM-S4-LA
Cleaning and Restoring Threaded Fasteners
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will demonstrate how to clean threaded fasteners; and,
   c. Student will demonstrate how to restore threaded fasteners.

IMM-S4-LW
Cleaning and Restoring Threaded Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

2. Student will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

3. Instructor will grade student's ability to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S5

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Fasteners and Preloading
Task: Torque/Preload Theory

Objective(s):

Upon completion of this module the student will be able to:

a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Instructional Materials:

MASTER Handout (IMM-S5-HO)
MASTER Self-Assessment
Classroom
Chalkboard

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S4 "Cleaning and Restoring Threaded Fasteners"

Introduction:

Proper torque is essential to mate two mechanical parts together.

Presentation Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S6) dealing with the effects of lubricating threads prior to torquing.

IMM-S5-HO
Torque/Preload Theory
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
11	Torque Wrench

Module Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques

Name:_____ Date:_____

IMM-S5
Torque/Preload Theory
Self-Assessment

1. Define torque.

2. Define preload.

3. List common torque pattern.

4. Define retorquing.

5. List common torque technique.

IMM-S5
Torque/Preload Theory
Self-Assessment Answer Key

1. A twisting force which tends to relate an object.

2. Start activity with a torqued valued at the beginning.

3. If several bolts are in a plate, tighten opposite sides and rotate around.

4. Apply additional 2nd torquing to an object.

5. Gradually apply pressure until predetermined value is reached.

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S6

Subject: Industrial Maintenance **Time: 4 Hrs.**

Duty: Fasteners and Preloading
Task: Effects of Lubricating Threads Prior to Torquing

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Instructional Materials:

MASTER Handout (IMM-S6-HO)
MASTER Laboratory Aid (IMM-S6-LA)
MASTER Laboratory Worksheet (IMM-S6-LW)
MASTER Self-Assessment
Lubricant
Torque wrench

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S5 "Torque/Preload Theory"

Introduction:

Lubrication is needed in many mechanical situations. This module deals with lubrication and torquing.

Presentation Outline:

I. Lubrication
II. Torquing
III. Torquing Without Lubricating
IV. Lubrication Plus Torquing

Practical Application:

1. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
2. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S7) dealing with demonstrating appropriate torquing technique.

IMM-S6-HO
Effects of Lubricating Threads Prior to Torquing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide***, Nelson, Audel Publishers, Latest Edition:

Chapter	**Title**
13	Mechanical Fasteners

Module Outline:

I. Lubrication
II. Torquing
III. Torquing Without Lubricating
IV. Lubrication Plus Torquing

IMM-S6-LA
Effects of Lubricating Threads Prior to Torquing
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
   c. Demonstrate what effects are seen by not lubricating threads prior to torquing.

IMM-S6-LW
Effects of Lubricating Threads Prior to Torquing
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how lubrication affects torquing.

2. Student will demonstrate how lubrication affects torquing.

3. Instructor will grade student's ability to demonstrate how lubrication affects torquing.

Name:_____ Date:_____

IMM-S6
Effects of Lubricating Threads Prior to Torquing
Self-Assessment

1. What effects are seen by lubricating threads prior to torquing.

_____
_____
_____
_____

2. What effects are seen by not lubricating threads prior to torquing.

_____
_____
_____
_____

IMM-S6
Effects of Lubricating Threads Prior to Torquing
Self-Assessment Answer Key

1. Lubrication causes threads to exhibit a smoother surface, therefore, making torquing activities easier.

2. Lack of lubrication causes threads to exhibit a rougher surface, therefore, making torquing activities more difficult because their is more friction..

INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-S7

Subject: **Industrial Maintenance** **Time 8 Hrs.**

Duty: **Fasteners and Preloading**
Task: Demonstrate Appropriate Torquing Technique

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Instructional Materials:

MASTER Handout (IMM-S7-HO)
MASTER Laboratory Aid (IMM-S7-LA)
MASTER Laboratory Worksheet (IMM-S7-LW)
MASTER Self-Assessment
Torque Wrenches

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing, Latest Edition
General Metals, Feirer, J. L., McGraw-Hill Publishers, Latest Edition
Machine Tool Practices, Kibbe, R. A., et al, John Wiley & Sons Publishing, Latest Edition
Machine Tool Operations: An Introduction, Matt, S. R., Wadsworth Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S6 "Effects of Lubricating Threads Prior to Torquing"

Introduction:

Proper torquing is essential to achieving a tight, uniform, well sealed mechanical parts.

Presentation Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing

Practical Application:

Student will demonstrate appropriate torquing technique.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

This completes the series of Industrial Maintenance Mechanic technical modules.

IMM-S7-HO
Demonstrate Appropriate Torquing Technique
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	**Title**
11	Torque Wrench

Module Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing

IMM-S7-LA
Demonstrate Appropriate Torquing Technique
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate appropriate torquing technique.

IMM-S7-LW
Demonstrate Appropriate Torquing Technique
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

2. Student will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

3. Instructor will grade student's ability to:
   a. List types of torque wrenches;
   b. Select appropriate torque wrench selection;
   c. Properly use torque wrench;
   d. Properly care of torque wrench; and,
   e. Torque fasteners.

Name:_____ Date:_____

IMM-S7
Demonstrate Appropriate Torquing Technique
Self-Assessment

1. List types of torque wrenches.

_____
_____
_____

2. List proper torque wrench selection.

_____
_____
_____

3. Explain use of torque wrench.

_____
_____
_____

4. Explain care of torque wrench.

_____
_____
_____

5. Explain how a torque wrench is used for fastener torquing.

_____
_____
_____

IMM-S7
Demonstrate Appropriate Torquing Technique
Self-Assessment Answer Key

1. Dial, lever

2. Adequate capacity to provide accuracy (25 to 75 is range). Avoid oversize torque wrench. Should torque wrench be pushed or pulled?

3. It is a combination wrench and measuring tool.

4. Use same care as used with other measuring devices.

5. Find out maximum torque for a specific fastener. Torque required to rotate a fastener before make up occurs is rundown resistance. When tight threads produce a run down resistance, torque required to overcome this resistance should be considered. In the last stages of rotation seizing of fastener may occur. If this happens back off and again apply tightening torque. The torque required to loosen a fasten is less than tightened torque.

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

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Industrial Maintenance Series

STUDENT LABORATORY MANUAL

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MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, AUGUSTA, GA
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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).**

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

DUTY A

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-A1-HO
Use Protective Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection

and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.

Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians, i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals
   - C. Working with multi strand steel cables
   - D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   - A. Plant engineering/ventilation
   - B. Use of respirators or bubble suits
   - C. Review OSHA requirements for fiber glass, asbestos and chemical protection

IMM-A1-LA
Use Protective Equipment
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical jcking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-A1-LW
Use Protective Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

IMM-A2-HO
Accident Prevention
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.
5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.

FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

- ☐ No make shift wiring
- ☐ Extension cords serviceable
- ☐ Motors and tools free of dirt and grease
- ☐ Lights clear of combustible materials
- ☐ Safest cleaning solvents used
- ☐ Fuse and control boxes clean and closed
- ☐ Circuits properly fused
- ☐ Equipment approved for use in hazardous areas (if required)
- ☐ Ground connection clean and tight

FRICTION

- ☐ Machinery properly lubricated
- ☐ Machinery properly adjusted and aligned.

SPECIAL FIRE-HAZARD MATERIALS

- ☐ Special isolation of flammable materials
- ☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

- ☐ Areas surveyed for fire safety
- ☐ Combustibles removed or covered
- ☐ Permit issued

OPEN FLAMES

- ☐ Kept away form spray rooms and booths
- ☐ Portable torches clear of flammable surfaces
- ☐ No gas leaks

PORTABLE HEATERS

- ☐ Set up with ample horizontal and overhead clearances
- ☐ Secured against tipping or upset
- ☐ Combustibles removed or covered
- ☐ Safely mounted on noncombustible surface
- ☐ Not used as rubbish burners

HOT SURFACES

- ☐ Hot pipes clear of combustible materials
- ☐ Ample clearance around boilers and furnaces
- ☐ Soldering irons kept off combustible surfaces
- ☐ Ashes in metal containers

SMOKING AND MATCHES

- ☐ "No smoking" and "smoking" areas clearly marked
- ☐ Butt containers available and serviceable
- ☐ No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION

- ☐ Flammable waste material in closed metal containers
- ☐ Flammable waste material containers emptied frequently
- ☐ Piled material cool, dry, and well ventilated
- ☐ Trash receptacles emptied daily

STATIC ELECTRICITY

- ☐ Flammable liquid dispensing vessels grounded or banded
- ☐ Moving machinery grounded
- ☐ Proper humidity maintained

HOUSEKEEPING

- ☐ No accumulations of rubbish
- ☐ Safe storage of flammables
- ☐ Passageways clear of obstacles
- ☐ Premises free of unnecessary combustible materials
- ☐ No leaks or dripping of flammables and floor free of spills
- ☐ Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT

- ☐ Proper type
- ☐ In proper location
- ☐ Unobstructed
- ☐ Clearly marked
- ☐ In working order
- ☐ Service date current
- ☐ Personnel trained in use of equipment

Module Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
      1. Recognizing when things are not as they should be
   B. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your coworkers' safety
      2. A state of mind that does not compromise safety for production or speed
      3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   A. Preparing to do the job
      1. Research task to insure it can be performed
      2. Appropriate tools and help are available
      3. Proper lockout procedure
   B. Select appropriate safety equipment
   C. Once the job starts, maintain a clean work place
   D. Avoid unsafe practices
      1. Failing to use safety equipment
      2. Performing task you are not qualified to perform
      3. Rushing
      4. Practical joking
      5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   A. Assure responsibility for your own safety
   B. Notify crew and supervision of an unsafe condition
   C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   A. Working with electricity
   B. Working near rotating equipment
   C. Working with chemicals and solvents
   D. Using pneumatic or hydraulic equipment
   E. Using ladders
   F. Lifting heavy objects
   G. Working in areas with harmful fumes

IMM-A3-HO
Working Aloft
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

Chapter	Title
9	Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

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Module Outline:

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
A. Equipment common to most personnel when working aloft
1. Safety glasses

2. Hard hat
3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

IMM-A3-LA
Working Aloft
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

IMM-A3-LW
Working Aloft
Attachment 3: **MASTER** Laboratory Worksheet

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
Note: This module does not address scaffolding erection because special training is required
   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance

B. **Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder**

IMM-A4-HO
Fire Safety
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

Chapter	Title
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

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Module Outline:

I. Technician's Responsibility

A. Each employer will have company specific rules
B. Unless the technician is part of the company fire fighting crew or fire brigade
    1. Notify every one in the area to evacuate
    2. Get to a phone and notify appropriate department
    3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
    4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
    A. Fuel
    B. Oxygen
    C. Heat

III. Four Classes of Fire
    A. Ordinary combustibles
    B. Flammable liquids
    C. Electrical
    D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
    A. Careless smokers
    B. Electrical overloads
    C. Inadequate fire watch for welding and cutting operations
    D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Fire Extinguisher
Agent Characteristics

Suitable for use on what type of fire: B C

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an "A" rating; however, they are designated as having "A" capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea

Average Size - 2 to 30 lbs. (11 to 23)
Horizontal Range - 5 to 20 ft. (15 to 30)
Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing

Average Size - 2 ½ to 20 lbs.
Horizontal Range - 3 to 8 ft.
Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing

Average Size - 2 ½ lbs.
Horizontal Range - 4 to 8 ft.
Discharge Time - 8 to 10 sec.

Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.

IMM-A4-LA
Fire Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-A4-LW
Fire Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standard of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers

IMM-A5-HO
Lifting Safety
Attachment 1: **MASTER** Handout

Standards pf performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide***, Carl Nelson, Audel Publishers, Latest Edition:

Chapter	Title
21	Rigging

Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet
II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.
   H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
III. Consequences of Improper Lifting
   A. Injury
   B. Loss time
   C. Possibility of becoming unemployed
IV. When Is It Unsafe to Lift an Object Alone
   A. Bulked load that restricts view
   B. When you would have to lift with your back rather than your legs
   C. When the object is too large to get a good grip
V. Discuss Handling Specific Shapes
   A. Locate center of gravity and use this area to lift
   B. Place as much weight as possible as close to lifting mechanism
   C. Place flat weight on button
VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
   A. Gloves
   B. Safety glasses
   C. Is the object being lifted a hazardous material?
VII. Discuss Equipment for Material Handling

A. Hand trucks
B. Powered trucks
C. Conveyers
D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people if one object is difficult to lift on side
C. Hold object tightly as handle is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
A. Formula for dealing with center of gravity
B. Identify parts of hoist
C. Safely demonstrate using a hoist
D. Identify types of loads
E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
1. Chains
a. Wear
b. Stretch
c. Distortion
d. Nicks
e. Cracks
f. Gauges
2. Slings
a. Wear
b. Stretch
c. Distortion
d. Flat, Sling Spots
D. Types
1. Slings
a. Choker

b. Double Choker
c. Bridle
d. Basket
e. Double Basket

IMM-A5-LA
Lifting Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-A5-LW
Lifting Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.

IMM-A6-HO
Lockout/Tagout
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency condition are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness pf employees role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147
II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between industry clearance procedures.
III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.

C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
   1. Static head pressure or induced thermal pressure
   2. Incline accumulators
   3. Unisolated automatic actuating valves, motors or relief
   4. System pressure
   5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
   1. Vent and drain valves
   2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
   3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
   1. Manual operated valves
   2. Pneumatic operated valves (fail open or closed)
   3. Hydraulic actuated valve
   4. Relief valves
   5. Fans
   6. Rollers

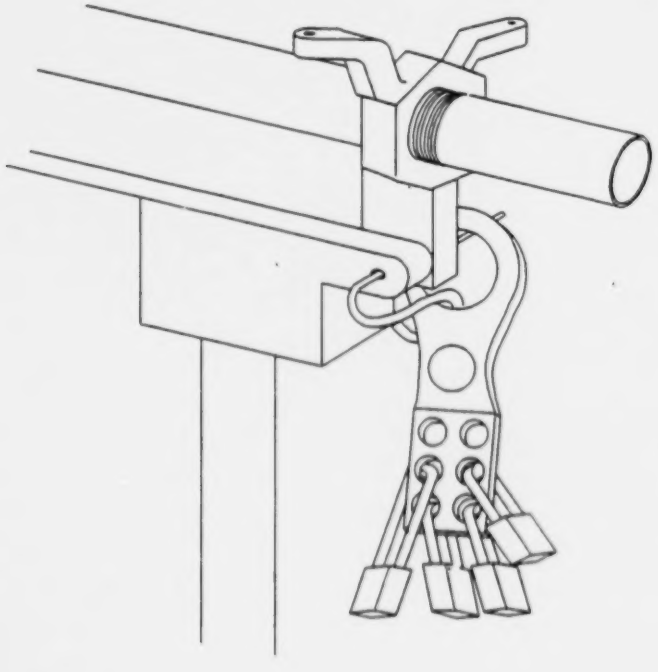
Reading Assignments:

Read the handout titled "Lockout and Tagout Procedures."

Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

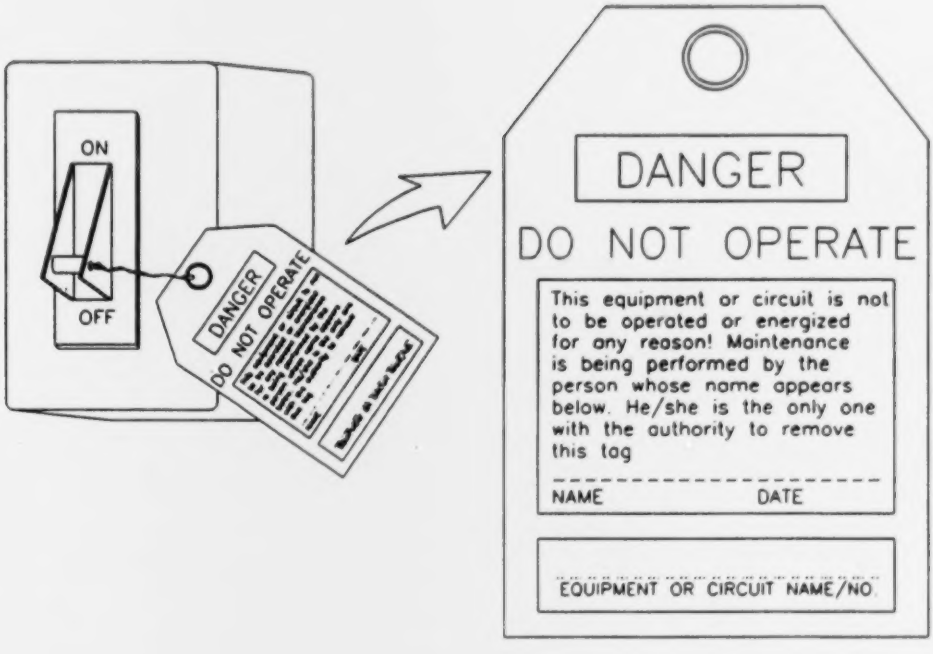
To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.



1 - A Lockout Device

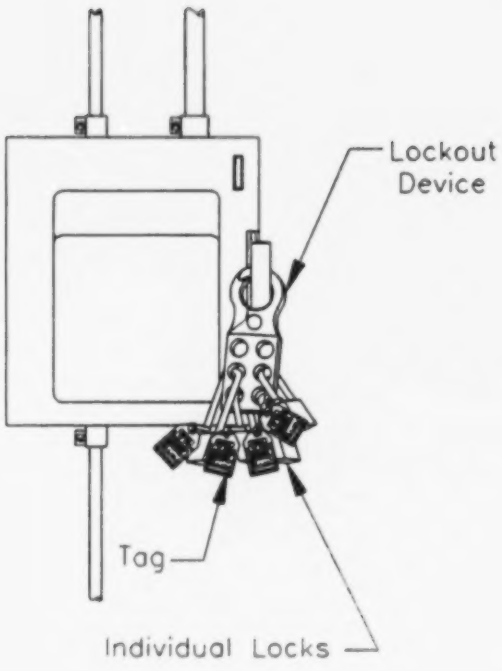
Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.


ON
OFF
DANGER
DO NOT OPERATE
DANGER
DO NOT OPERATE
This equipment or circuit is not to be operated or energized for any reason! Maintenance is being performed by the person whose name appears below. He/she is the only one with the authority to remove this tag
NAME
DATE
EQUIPMENT OR CIRCUIT NAME/NO.

2 - Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.



3 - Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.

Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-A6-LW
Lockout/Tagout
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

1973

DutyB

1973

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate math skills acquired in this module by:
Actively participating in class; and,
Working problems in this module;

Objectives:

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals;
h. Divide decimals;
i. Locate any decimal place to the millionths;
j. Read numbers containing decimals;
k. Write numbers containing decimals;
l. Round off a decimal to a specified place value;
m. Align decimal points before computation;
n. Add numbers containing decimals;
o. Subtract numbers containing decimals;
p. Multiply numbers containing decimals; and,
q. Divide numbers containing decimals.

Module Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Decimal System Place Value
VI. Add Decimals
VII. Subtract Decimals
VIII. Multiply Decimals
IX. Divide Decimals

IMM-B1-LW
Perform Basic Arithmetic Functions
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

Give the place value of the 5 in the numbers below:

1. 16.53 _____
2. 0.4565 _____
3. 51,345 _____

Write the numbers below in words:

4. 0.000052 _____
5. 0.013 _____
6. 0.0008 _____
7. 15,248 _____

Write the numbers that are indicated by the following phrases:

8. Three thousandths _____
9. Seventy-five and sixty seven hundredths _____
10. Eighty-six hundred ten-thousandths _____

Round these numbers to the specified place value:

		Thousandths	Tenths	Hundredths
11.	2.75	_____	_____	_____
12.	18.613	_____	_____	_____
13.	0.22	_____	_____	_____

14. 14.2343 _____ _____ _____

15. When adding or subtracting decimals, be sure the decimal points are _____.

Add or subtract the following:

16. 0.7 + 14 + 16.2 = _____

17. 74 + 890 + 0.0057 - 46.72 = _____

18. 42.6 + 0.0131 = _____

19. It is not necessary to align the _____ _____ in a multiplication problem.

20. The number of digits behind a decimal point in the _____ equals the number of digits behind decimal points in the _____ _____ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.

21. 254.8 x 14 = _____

22. 6,000 x 0.021 = _____

23. 152.33 x 3.5 = _____

24. 16.8 x 101.6 = _____

25. To multiply a number by a multiple of 10, simply count the number of zeros in the _____ and move the decimal point in the _____ the same number of places.

Use the short cut method to solve the following problems:

26. 15.1 x 10,0001 = _____

27. 0.44 x 102 = _____

Solve the following problems, using zeros as place holders if necessary:

28. 6099.6 divided by 16.5 = _____

29. 1509.04 divided by 2.3 = _____

30. When dividing by a multiple of 10, move the decimal point to the _____ the same number if spaces as there are zeros in the _____.

Use the short cut method of dividing by multiples of 10 to solve the following problems:

31. 0.053 divided by 1000 = _____

32. 14.954 divided by 10 = _____

33. 110 divided by 1000 = _____

34. 436.89 divided by 100 = _____

IMM-B2-HO
Convert Fractions/Decimals
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate ability to work with fractions, convert fractions to decimals, and decimals to fractions.

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;
b. Reduce fractions to their lowest terms;
c. Define prime number and composite number;
d. Define common fractions and uncommon fractions;
e. Add fractions;
f. Find the common denominator of a number of fractions;
g. Subtract fractions;
h. Define mixed number;
i. Define improper fractions;
j. Change mixed numbers to improper fractions;
k. Change improper fractions to mixed numbers;
l. Reduce improper fractions to their lowest terms;
m. Add improper fractions;
n. Subtract improper fractions;
o. Multiply fractions; and,
p. Divide fractions.

Reading Assignments:

The following chapters are assigned to read from ***Math for Consumers***, by D.S. Kaine and L.S. Kaine, Addison-Wesley Pub. Co., Latest Edition:

Chapter	**Title**
	Fractions and Operations

Module Outline:

I. Introduction - Define Fractions
II. Reducing Fractions
III. Adding Fractions
IV. Subtracting Fractions
V. Improper Fractions

VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means "equal to" but not necessarily "identical to."

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.

IMM-B2-LW
Convert Fractions/Decimals
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

Reduce the following fractions to their lowest terms:

1. 4/24 = _____
2. 8/32 = _____
3. 2/18 = _____
4. 36/72 = _____
5. 10/16 = _____

Change the mixed numbers to improper fractions.

1. 9 3/4 = _____
2. 5 7/8 = _____
3. 4 9/32 = _____

Solve the following problems.

1. 2/7 x 6/11 = _____
2. 5/9 x 8/3 = _____
3. 2/3 x 1/10 = _____
4. 5/7 divided by 2/3 = _____
5. 7/8 divided by 1/4 = _____
6. 3/4 divided by 2/9 = _____

Convert decimals to fractions or fractions to decimals.

1. 12/15 = _____

2. 3/5 = _____

3. 11/17 = _____

4. 0.6 = _____

5. 0.875 = _____

6. 0.88 = _____

IMM-B3-HO
Convert Metric/English Measurements
Attachment 1: **MASTER** Handout

Standards of Performance:

Student shall demonstrate ability to convert English units to metric units and convert metric units to English units.

Objectives:

Upon completion of this module the student will be able to:

a. Name the three basic units of metric system measurement;
b. Match the six most commonly used metric system prefixes with their meaning;
c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;
d. Add and subtract metric-system units;
e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and,
f. Convert metric units to English units and English units to metric units.

Conversion Chart:

Metric to English

Length
1mm = 0.04 in
1 cm = 0.39 in
1 m = 39.37 in = 3.28 ft
1m = 1.09 yd
1 km = 0.62 mi

Weight
1 g = 0.035 oz
1 kg = 2.2 lb

Volume
1 ml = 0.2 tsp
1 l = 1.057 qt

English To Metric

Length
1 in = 2.54 cm
1 ft = 30.48 cm = 0.305
1 yd =0.914 m
1 mi = 1.609 km

Weight
1 oz = 31.103 g
1 lb = 0.453 kg

Volume
1 tsp = 5 ml
1 c = 284 ml
1 qt = 0.946 l
1 gal = 3.785 l

Common abbreviations used above:

c	=	cup
cm	=	centimeter
ft	=	foot
g	=	gram
gal	=	gallon
in	=	inch
kg	=	kilogram
km	=	kilometer
l	=	liter
lb	=	pound
m	=	meter
mi	=	mile
ml	=	milliliter
mm	=	millimeter
oz	=	ounce
qt	=	quart
tsp	=	teaspoon
yd	=	yard

Reading Assignments:

The following chapters are assigned to read from ***Math for Consumers***, by D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Subject - Metric System

Module Outline:

I. English System
II. Metric System
III. Metric Prefixes
IV. Moving Decimal
V. Metric Length
VI. Metric Weight
VII. Metric Volume
VIII. Metric Temperature
IX. Converting English to Metric Units
X. Converting Metric to English

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means "equal to" but not necessarily " identical to".

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.

IMM-B3-LW
Convert Metric/English Measurements
Attachment 2: MASTER Laboratory Worksheet

Perform operations, as indicated.

1. There are _____ kilograms in a metric ton.
2. 100.9 g - 74.99 g =_____ g
3. 93.6 cg + 1,189 cg =_____cg

Perform the conversions. Round your answer to two places.

1. 34 g =_____oz
2. 92 cm =_____ft
3. 890 l =_____gal
4. 15 cm =_____in
5. 58.5 kg =_____lbs

IMM-B4-HO
Perform Basic Algebraic Operations
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses ( ) or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.

6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fractions numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity form one side of an equation to the other, you change its sign or operation.

Reading Assignments:

The following chapaters are assigned to read from ***Math for Consumers***, D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Chapter	**Title**
	Equation Solving

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
A statement that two quantities are equal.

Formula

A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term

Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation

The process of moving a quantity from one side of an equation to the other by changing its sign of operation.

IMM-B4-LW
Perform Basic Algebraic Operations
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

   _____

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

   _____

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

   _____

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.

   _____

IMM-B5-HO
Perform Basic Trigonometric Functions
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation.;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from *Mathematics for Technicians* by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
9	Trigonometry

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation

VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

IMM-B5-LW
Perform Basic Trigonometric Functions
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

(Use Trig Function Tables)

Solve:

1. Sin 22° 18' = _____
2. Cot 22° 18' = _____
3. Sec 22° 18' = _____
4. Tan 22° 18' = _____
5. Csc 22° 18' = _____
6. Cos 22° 18' = _____
7. Cos A = 0.69675 _____
8. Cot A = 1.1340 _____
9. Sin A = 0.98531 _____
10. Sec A = 1.5753 _____
11. Tan A = 0.50587 _____
12. 2π Radians = _____ Degrees
13. 180 Degrees = _____ Radians
14. π Radians = _____ Degrees

IMM-B6-HO
Perform Basic Geometric Calculations
Attachment 1: **MASTER** Handout

Standards of Performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

IMM-B6-LA
Perform Basic Geometric Calculations
Attachment 2: **MASTER** Laboratory Aid

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Reading Assignments:

The following chapters are assigned to read from ***Math for Technician***, by Edward Trunaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
8	Fundamentals of Geometry

Module Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism

IMM-B6-LW
Perform Basic Geometric Calculations
Attachment 3: **MASTER** Laboratory Worksheet

Practice Working Problems In The Following Areas:

a. Angles;
b. Triangle;
c. Circle;
d. Sphere;
e. Cone;
f. Solid;
g. Cylindrical;
h. Polygon; and,
i. Prism.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical hand saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-C1-HO
Identify Basic Types of Drawings
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate how to identify basic types of drawings within 85% accuracy.

Objectives:

Upon completion of this module the student will be able to:

a. Identify mechanical drawings;
b. Identify electrical drawings;
c. Identify process drawings;
d. Identify welding drawings; and,
e. HVAC drawings.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading and Sketching***, Kirk Patrick, Latest Edition:

Chapter	Title
1	Introduction
2	Drawing Formula
21	Welding Assemblies
24	Reading Electrical and Electronics Schematic Diagrams

Module Outline:

I. Basic Types of Drawings.
   A. Mechanical
   B. Electrical
   C. Process
   D. Welding
   E. Sketch
   F. Plot plans
   G. Floor plans
   H. Contour maps
   I. Elevations
   J. Architectural
   K. Engineering Drawings

II. Mechanical

A. One view drawings
B. Two view drawings
C. Three view drawings
D. Auxiliary views
E. Isometric views
F. Orthographic views
G. Pictorial views
H. Oblique views
I. GD&T
J. Assembly
K. Hydraulic drawings
L. Pneumatic drawings
M. Machine drawings
N. Parts
O. Explored views

III. Electrical
A. Schematic diagrams
B. Single line diagrams
C. Wiring diagrams
D. Pictorial diagrams
E. Block diagrams
F. Symbols
G. Distribution
H. Plant wiring diagram

IV. Process
A. Block diagram
B. Flow diagram
C. P&ID or EFG diagram
D. Symbols
E. Piping diagrams

V. Welding
A. Symbols
B. Assembly
C. Views

VI. HVAC
A. Sheet metal
B. Ducts, duct sections
C. Diffusers
D. Triangulation

IMM-C2-HO
Identify Basic Layout of Drawings
Attachment 1: **MASTER** Handout

Objectives:

Upon completion of this module the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading & Sketching*** ,Kirk Patrick, Latest Edition:

Chapter	Title
9	Lines For Drawings
12	Reading Two Dimensioning Drawings
15	Sectional Views
16	Auxiliary Views

Module Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing

IMM-C2-LW
Identify Basic Layout of Drawings
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Draw an isometric sketch of an object furnished by instructor.

2. Draw a three dimensional sketch of an object furnished by instructor.

3. Draw an orthographic sketch of an object furnished by instructor.

IMM-C3-HO
Review Blueprint Notes and Dimensions
Attachment 1: **MASTER** Handout

Objectives:

Upon completion of this module the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Reading Assignments:

The following chapters are assigned to read from ***Industrial Blueprint Reading and Sketching***, Kirk Patrick, Latest Edition:

Chapter	Title
1	Introduction
17	Dimensioning
18	Tolerances

Module Outline:

I. Major Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-D1-HO
Use Non-Precision Measuring Tools
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use steel rule;
b. Properly use folding rule;
c. Properly use steel tape;
d. Properly use outside calipers; and,
e. Properly use inside calipers.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, by Krar, McGraw-Hill Company, Latest Edition:

Chapter	Title
7	Measurement

Module Outline:

I. Introduction
II. Steel Rule
III. Folding Rule
IV. Steel Tape
V. Outside Calipers
VI. Inside Calipers

IMM-D1-LA
Use Non-Precision Measuring Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-D1-LW
Use Non-Precision Measuring Tools
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

2. Instructor will grade the student's use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

IMM-D2-HO
Use Precision Measuring Tools
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use vernier calipers;
b. Properly use outside and inside micrometers;
c. Properly use depth gauges; and,
d. Properly use dial indicators.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools,* by Krar, McGraw-Hill, Latest Edition:

Chapter	Title
9	Micrometer
10	Vernier Calipers
11	Inside, Depth and Height Measuring Instruments

Module Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge

IMM-D2-LA
Use Precision Measuring Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-D2-LW
Use Precision Measuring Tools
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

2. Student will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

3. Instructor will grade student's ability to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gauges
   e. Dial Indicators

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Trouble shoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-E1-HO
Identify and Use Maintenance Technician's Hand Tools
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will demonstrate the:

a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Module Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers

IMM-E1-LA
Identify and Use Maintenance Technician's Hand Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-E1-LW
Identify and Use Maintenance Technician's Hand Tools
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear Plugs
   Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

IMM-E2-HO
Identify and Use Hand Held Power Tools
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Identify typical use and application of a hand drill and a hand power screwdriver;
b. Identify typical use and application of a reciprocating saw;
c. Identify typical use and application of a circular saw;
d. Identify typical use and application of hand held high-speed pneumatic tools;
e. Identify typical use and application of a hand held electric or pneumatic side grinder;
f. Identify typical use and application of electric or pneumatic impact tools; and,
g. Demonstrate safe operation of hand held power tools to established performance measures.

Module Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation
   D. Application
II. Identify Typical Use and Application for a Reciprocating Saw
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application
III. Identify Typical Use and Application of a Circular Saw
   A. Safety

B. Selecting proper blade
C. Operation
D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
A. Safety
B. Selecting proper tool bits
C. Operation
D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
A. Safety
B. Selecting proper grit wheel
C. Operation
D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
A. Safety
B. Selecting proper blade
C. Operation
D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures

IMM-E2-LA
Identify and Use Hand Held Power Tools
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

IMM-E2-LW
Identify and Use Hand Held Power Tools
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Safety glasses
   Leather gloves
   Face shields
   Ground fault protector
   Safety curtains lab equipment

3. Lab Equipment:
   - Hand drill and power screwdriver
     - Assorted drill bits
     - Assorted screwdriver bits
     - Chuck key
     - Material suitable for practice and demonstration
   - Reciprocating saw.
     - Assorted blades
     - Material suitable for practice and demonstration
     - Allen wrench
   - Circular saw.
     - Assorted blades
     - Material suitable for practice and demonstration
     - Wrench appropriate to install blade
   - Hand held electric-speed pneumatic pencil/pewee grinder
     - Assorted cut off, grinding and polishing wheels
     - Assorted carbide burrs
   - Hand held electric or pneumatic side grinder.
     - Assorted grit grinding wheels
   - Electric/pneumatic impact tools.
     - Material suitable for practice and demonstration
     - Impact socket set
     - Impact chisel

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercise using each tool in No. 3 above.

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Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
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H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

DMM PM1
7/90/90

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-F1-HO
Use and Care of Milling Machines
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall:

1. Identify the two major factors in working safely;
2. List four steps you can take prior to performing work that will insure a safe outcome;
3. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
4. Select specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to demonstrate proper use of milling machines to include:

a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, by Krar, McGraw-Hill Pub., Latest Edition:

Chapter	Title
12	Milling Machine

Module Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Dept of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling

IX. Cam, Worm Milling
X. Vertical Milling Machine

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

IMM-F1-LW
Use and Care of Milling Machines
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate:
   - A. Milling Machine and Accessories
   - B. Milling Cutters
   - C. Speeds, Feeds and Dept of Cut
   - D. Setups
   - E. Operations (Horizontal)
   - F. Indexing
   - G. Gear Cutting
   - H. Helical Milling
   - I. Cam, Worm Milling
   - J. Vertical Milling Machine

2. Student will be graded on proper operation and part fabrication by milling machine.

IMM-F2-HO
Use and Care of Horizontal and Vertical Band Saws
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of horizontal band saw; and,
b. Demonstrate proper use and care of vertical band saw.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools,* by Krar, McGraw-Hill Publishing, Latest Edition:

Unit	Title
35	Types of Metal Saws
36	Bandsaw Parts and Accessories
37	Bandsaw Operations

Module Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   A. Blade
   B. Blade guard
   C. Coolant system (if used)

D. Work clamp (if used)
E. Blade tensioning device
F. On/off and feed controls

II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw
   A. Blade
      1. Different types
   B. Blade guard
      1. Adjustment techniques
   C. Coolant system (if used)
      1. Types of coolant
      2. When coolant is needed
      3. Adjusting flow control
   D. Work clamp (if used)
      1. Purpose
      2. How to adjust
   E. Blade tensioning device
      1. How to tighten and loosen
      2. Recognizing proper tension
   F. On/off and feed controls
      1. On-off and remote power switches
      2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw
   A. How to loosen
   B. Correct operating position
   C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation
   A. Airborne derbies
   B. Exposed cutting surface
   C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades

IMM-F2-LA
Use and Care of Horizontal and Vertical Band Saws
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.

IMM-F2-LW
Use and Care of Horizontal and Vertical Band Saws
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

2. Student will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

3. Instructor will grade student's performance.

IMM-F3-HO
Use and Care of Pedestal Grinder
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Reading Assignments:

The following chapters are assigned to read from ***Technology of Machine Tools,*** by Krar, McGraw-Hill Publications, Latest Edition

Unit	**Topic**
85	Cylinder Grinder

Module Outline:

I. Identify the Component Parts of a Pedestal Grinder
   A. Pedestal
   B. Motor
   C. Spindle
   D. Toolrest (guard)

E. Grinding wheel and vibration pads
F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
A. Different types of dressing tools
B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
A. Fast feed-rapid metal abrasion with course finish
B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
A. Blocking spindle rotation
B. Removing guards
C. Removing mounting nut and washers
D. Sounding a wheel for flaws
E. Mounting the wheel, vibration pads, washer and nut
F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
A. Flying grinding dust
B. Disintegrating wheel
C. Wheel may throw small parts
D. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)

IMM-F3-LA
Use and Care of Pedestal Grinder
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

IMM-F3-LW
Use and Care of Pedestal Grinder
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

2. Student will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

3. Instructor will grade student's performance on:
   A. Demonstrating proper use and care of pedestal grinder; and,
   B. Set up and operating a pedestal grinder without endangering personnel or equipment.

IMM-F4-HO
Use and Care of Surface Grinder
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools* by Krar, McGraw-Hill Publisher, Latest Edition:

Unit	Title
82	Types of Abrasives
83	Surface Grinders and Accessories
84	Surface Grinding Operations

Module Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat

II. Identify the Component Parts of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
   A. Clamping using a magnetic base
   B. Clamping using dogs

V. Describe the Relationship Between Speed , Feed and Surface Quality.
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

VI. Identify Safety Concerns Relative to Using a Surface Grinder
   A. Work coming loose
   B. Flying debris
   C. Wheel disintegrating
   D. Moving parts

VII. Setup and Operate a Surface Grinder to a Tolerance of .002" Without Endangering Personnel or Equipment

IMM-F4-LA
Use and Care of Surface Grinder
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-F4-LW
Use and Care of Surface Grinder
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

2. Student will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

3. Instructor will grade student's performance on setup and operating a surface grinder to a tolerance of .002 without endangering personnel of equipment.

IMM-F5-LA
Operate Lathes
Attachment 1: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

MASTER Video Tape (IMM-F5-VT1)

"Feeds and Speeds"

IMM-F5-HO
Operate Lathes
Attachment 2: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, Krar, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
45	Component Parts
46	Accessories
47	Feeds and Speeds
48	Safety
49	Mounting and Removing Centers
50	Grinding Lathe Tools
51	Facing Between Centers
52	Machining Between Centers
54	Turning Tapers Using Compound Rest

Module Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile
II. Identify and Discuss Component Parts of an Engine Lathe
   A. Control panel

B. Bed & ways
C. Head stock
D. Gear box
E. Carriage
F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
A. Centers
B. Chucks
C. Faceplates
D. Mandrels
E. Steady and follower rest
F. Lathe dogs
G. Driver plates
H. Tool holders
I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
A. Steel
B. Aluminum
C. Brass

V. Discuss Lathe Safety
A. Clamping of work
B. Watches & rings
C. Housekeeping
D. Chuck wrenches
E. Removing chips
F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
A. Mounting
B. Removing
C. Aligning

VII. Discuss and Demonstrate Use of Cutting Tools
A. Grinding a toolbit
B. Conditioning point of bits
C. Types of cutting tools

VIII. Discuss and Demonstrate Turning Between Centers
A. Why face cut
B. Center drill
C. Using a tailstock center
E. Using steady rest
F. Using chucks

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe

IMM-F5-LW1
Operate Lathes
Attachment 3: **MASTER** Laboratory Worksheet

WORK SHEET 1:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Tool grinder
   - Hand tools as required to operate lathe
   - Set of inside and outside micrometers up to 3"
   - Telescoping gages
   - Dial calipers
   - Toolstock
   - Face shield
   - Side shields
   - 3-6" sections of bar stock for practice
   - Drill and sleeve appropriate to hole required
   - Reamer appropriate for hole required
   - Lathe with accessories suitable for project

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises tool grinding:
   A. Grind lathe cutting tool appropriate to metal being turned. **(Instructor must see lathe tool prior to proceeding.)**

5. Practice exercise lathe familiarization.
   A. Student shall practice using lathe controls until familiar.
      (1) Selecting speeds & feeds (use of S & L chart).
      (2) Start and stopping of machine and emergency stop.
      (3) Engage and disengage feed controls.
      (4) Positioning tool in tool holder.
   B. Student shall practice using accessories.
      (1) Centering stock in available chucks.
      (2) Setting up stock between centers.
      (3) Running machine with stock mounted in the chuck.
   C. Lathe operation.
      (1) Practice taking cuts using manual feed
      (2) Practice taking cuts using the engine driven feed and speed controls.
      (3) Practice center drilling.

(4) Practice drilling with the drill bit mounted in the tail stock.
(5) Practice reaming.
(6) Practice cutting a taper using the compound rest (manual feed).

D. Fabricate a part to tolerances specified on the drawing provided.

IMM-F5-LW2
Operate Lathes
Attachment 4: **MASTER** Laboratory Worksheet

WORKSHEET 2:

1. This exercise will combine the skills and knowledge practices in previous lab exercises to fabricate the component described by attachment V.

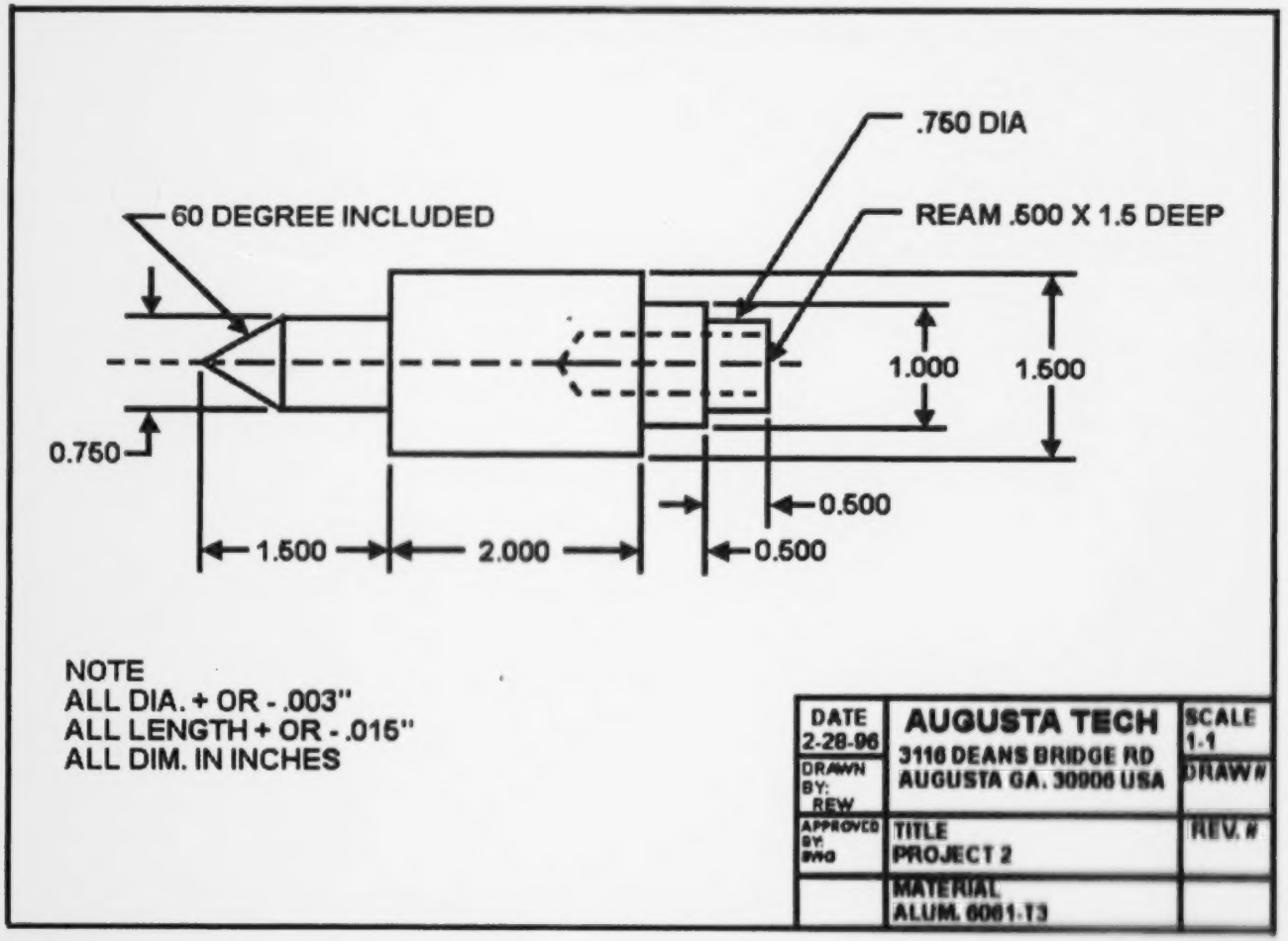
2. Pre-established safety concerns by the drawing.

3. Maintain tolerances by the drawing.

The project will require the student to demonstrate skills and knowledge in the following:

Practice safety
Basic math
Blueprint reading
Measuring instruments
Pedestal grinder operation
Lathe operation

Attachment 5 consists of a drawing of project 2.



IMM-F6-HO
Use and Care of Drill Press
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools* by Krar, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
38	Drill Press
39	Drilling Machine Accessories
40	Twist Drills
41	Cutting Speeds and Feeds
42	Drilling Holes
43	Reaming
44	Drill Press Operations

Module Outline:

I. Identify Major Components
   A. Bed/table
   B. Motor
   C. Speed/feed/directional controls

D. Start/stop/emergency stop
E. Coolant system
F. Drill head
G. Column
H. Spindle
I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
A. Speed, feed and directional control
B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
A. Compound rest
B. Clamping dogs
C. Tapered shank drill sleeves
D. Drill chuck
E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
A. Hot chips
B. Sharp edges
C. Flying derbies

V. Demonstrate the Setup and Safely Operate a Radial Arm Drill Press to a Specified Standard

IMM-F6-LA
Use and Care of Drill Press
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall identify the two major factors in working safely by:

1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

IMM-F6-LW
Use and Care of Drill Press
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The Instructor will:
   - A. Identify major components.
     - (1) Bed/table
     - (2) Motor
     - (3) Speed/feed/directional controls
     - (4) Start/stop/Emergency Stop
     - (5) Coolant system
     - (6) Drill head
     - (7) Column
     - (8) Spindle
     - (9) Radial arm
   - B. Describe the function and demonstrate operations of all controls.
     - (1) Speed, feed and directional control
     - (2) Raise, lower and position drill head
   - C. Describe and demonstrate the use of accessories found on most radial arm drills.
     - (1) Compound rest
     - (2) Clamping dogs
     - (3) Tapered shank drill sleeves
     - (4) Drill chuck
     - (5) Fly cutter
   - D. Describe the safety concerns associated with operation of a radial arm drill.
     - (1) Hot chips
     - (2) Sharp edges
     - (3) Flying derbies
   - E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

2. Student will:
   - A. Identify major components.
     - (1) Bed/table
     - (2) Motor
     - (3) Speed/feed/directional controls
     - (4) Start/stop/Emergency Stop
     - (5) Coolant system
     - (6) Drill head
     - (7) Column

(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges
(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

3. Instructor will grade student on:

A. Identify major components.
(1) Bed/table
(2) Motor
(3) Speed/feed/directional controls
(4) Start/stop/Emergency Stop
(5) Coolant system
(6) Drill head
(7) Column
(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges

(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machine	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-G1-HO
Weld with Shielded Metal Arc Welding (SMAW) Process
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:

1. Using OSHA required safety equipment for the shop;
   Safety glasses;
   Hearing protection;
   Face shields;
   Gloves;
2. Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
3. Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Weld with shielded metal arc (SMAW) process.

Reading Assignments:

The following chapters are assigned tor ead from ***Welding Skills and Practices,*** by Week, Published by ATS, Latest Edition:

Chapter	Topic
5	Machines and Accessories
6	Selecting the Electrode
7	Striking an Arc
8	Running Continuous Beads
9	The Flat Position
10	The Horizontal Position
11	The Vertical Position
12	The Overhead Position
13	Cast Iron
14	Carbon Steels
15	Alloy Steels
16	Non-Ferrous Metals

Module Outline:

I. Machines and Accessories
   A. Selecting the electrode

II. Striking an Arc
III Running Continuous
IV. The Flat Position
    A. The horizontal position
    B. The vertical position
    C. The overhead position
    D. Cast iron
    E. Carbon steels
    F. Alloy steels
    G. Non-ferrous metals

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

- **A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.**
- **B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.**
- **C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.**
- **D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.**

CAUTION: Electrical shock can be avoided by following specific safety precautions.

- **A. Do not touch live electrical parts.**
- **B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.**
- **C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.**
- **D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.**
- **E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.**
- **F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.**
- **G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.**

H. **Shut off electrical power when working on welding equipment.**

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. **Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.**
B. **Cover all skin surfaces. Keep shirt sleeves rolled down.**
C. **Wear cuffless pants to eliminate spatter traps.**
D. **Wear leather boots. Pant legs should cover boot tops.**
E. **Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.**
F. **For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.**
G. **Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.**
H. **Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.**
I. **Wear a 100% cotton cap to protect the head from sparks or spatter.**
J. **Wear long gauntlet leather gloves.**
K. **Do not touch hot metal with bare hands. Use pliers and wear leather gloves.**
L. **Protect nearby workers from exposure to the welding arc by putting up shields.**
M. **Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).**

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

FIGURE 2 FILTER RECOMMENDATIONS

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

- **A. If possible, weld in specially designated areas or enclosures of noncombustible construction.**
- **B. Remove combustibles from the work area by at least 35 feet if possible.**
- **C. Cover combustibles that cannot be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.**
- **D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.**
- **E. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.**
- **F. Do not weld on materials having either a coating or internal structure that is combustible.**
- **G. Place hot scrap and slag in non-combustible containers.**
- **H. Ensure that fire extinguishers are available nearby.**

I. **Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.**

J. **Follow all company safety procedures regarding welding in hazardous areas.**

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails. DON'T CARRY A BOMB IN YOUR POCKET.

IMM-G1-LW
Weld with Shielded Metal Arc Welding (SMAW) Process
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Choose Proper Power Source

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. Choose a Proper Electrode

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The *E6010* belongs to the *fast-freeze* family of electrodes and the *E7018* belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: **Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.**

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

FIGURE 5 WELDING ROD POLARITIES

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	--	20-40	20-40	--	--	--	--	--	--
5/64	--	25-60	25-60	--	--	--	--	--	--
3/32	40-80	35-85	45-90	--	--	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

FIGURE 6 TYPICAL CURRENT RANGES FOR ELECTRODES

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:
   (1) Product design
   (2) Material thickness
   (3) Design strength requirements
   (4) Welding process employed

b. SMAW weld joint configuration may be a:
   (1) Lap joint
   (2) Tee joint
   (3) Corner joint
   (4) Edge joint
   (5) Butt joint with backing
   (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing

b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on

the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.

a. When making **seam welds**, produce the weld beads by using very little oscillation or some oscillation.

b. When making **fillet welds**, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.

c. When making **groove welds**, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a **decrease in travel speed** will result in an increase in the weld bead height and width, and an **increase in travel speed** will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW

process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip, or
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it (see Figure 7).

IMM-G2-HO
Weld/Cut with Oxyacetylene
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

READING ASSIGNMENTS:

The following chapters are assigned to read from ***Basic Oxyacetylene Welding***, Griffin, Delmar Publishers, Latest Edition.

Chapters	Title
Unit 1	The Oxyacetylene Welding Process
Unit 2	Oxygen and Acetylene Cylinders
Unit 3	Welding Gases
Unit 4	Oxygen and Acetylene Regulators
Unit 5	Types and Uses of Welding Torches
Unit 6	Welding Tips
Unit 7	The Oxyacetylene Welding Flame

Chapters	Title
Unit 9	Flame Cutting
Unit 10	Straight Line Cutting
Unit 11	Bevel Cutting
Unit 12	Piercing and Hole Cutting
Unit 13	Welding Symbols
Unit 14	Running Beads and Observing Effects
Unit 15	Making Beads with Welding Rod
Unit 16	Tacking Light Steel Plate and Making Butt Welds
Unit 17	Flat Corner Welds
Unit 18	Lap Welds on Light Steel Plate
Unit 19	Tee or Fillet Welds on Light Steel Plate
Unit 20	Beads or Welds on Heavy Steel Plate
Unit 21	Manipulation of Welding Rod on Heavy Steel Plate
Unit 22	Butt Welds on Heavy Steel plate
Unit 23	Lap Welds on Heavy Steel Plate
Unit 24	Fillet Welds on Heavy Steel Plate
Unit 25	Beveled Butt Weld on Heavy Steel plate
Unit 26	Backhand Welding on Heavy Steel Plate
Unit 27	Backhand Welding of Beveled but Joints

Module Outline:

I. Gas Cutting Safety
II. Gas Cutting Fundamentals
III. Gasses
IV. Cylinders
V. Regulators
VI. Valves
VII. Oxygen
VIII. Oxygen Hoses
IX. Acetylene
X. Acetylene Hoses
XI. Cutting Torch and Tips
XII. Flame
XIII. Setting Up Equipment

XIV. Light Torch
XV. Cutting Procedure
XVI. Welding Procedure

Caution: **Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.**

a. **Use goggles or shield with a number five shade.**
b. **Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.**
c. **When lighting the torch, direct the torch away from yourself and other personnel.**
d. **Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.**
e. **Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.**
f. **Never cut on containers that have contained flammable or toxic substances.**
g. **Either move work away from or protect wooden or other flammable materials which may be close to the work.**
h. **When cutting, cover concrete floors with sheet metal where sarks and molten metal are being directed.**
i. **Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.**
j. **Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.**
k. **Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.**

Caution: **Handle acetylene and oxygen cylinders carefully:**

a. **Keep acetylene operating pressures at or below 15 psi.**
b. **Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.**
c. **Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.**
d. **Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.**

e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

IMM-G2
Weld/Cut with Oxyacetylene
Attachment 3: **MASTER** Laboratory Worksheet

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of R.B.O.?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.

h. When cutting, cover concrete floors with sheet metal where sparks and molton metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with hand-wheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's *current* contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of R.B.O.
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.

c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
d. Attach the regulators, hoses, torch, and correct-sized torch tip.
e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counter-clockwise until there is a little free play.)
f. Make sure all cutting torch valves are initially closed.
g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
h. Open the acetylene torch valve. Turn the acetylene torch valve off.
I. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. *Immediately* light the torch with a *friction lighter only*.
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the *neutral* type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut—assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame

b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.

c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to ⅛" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.

d. Select the correct torch angle.
   (1) For ***square cuts***, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
   (2) For ***beveled cuts***, the torch should be held at the angle of the bevel throughout the cutting procedure.
   (3) For ***holes***, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the ***correct travel speed***, the lines of the cut which project through the thickness of the base metal will be in a straight line. At ***too fast a travel speed***, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed ***lag*** or ***drag*** lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

IMM-G3-HO
Perform Gas Soldering
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Preform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Reading Assignments:

The following chapters are assigned to read from *Basic Oxyacetylene Welding*, by Griffin, Delmar Publishers, Latest Edition

UNIT	TITLE
Unit 28	Brazing with bronze Rod
Unit 29	Running Beads with Bronze Rod
Unit 30	Square Butt Brazing on Light Steel Plate
Unit 31	Brazed Lap Joints
Unit 32	Brazing Tee Joints
Unit 33	Brazing Beveled butt Joints on Heavy Steel Plate
Unit 34	Building-Up on Cast Iron

Unit 35	Brazing Beveled Joints on Cast Iron
Unit 36	Silver Soldering Nonferrous Metals
Unit 37	Silver Soldering Ferrous and Nonferrous Metals

Module Outline:

I. Oxyacetylene Soldering Safety
II. Soldering with Oxyacetylene
III. Equipment Set Up
IV. Light Torch
V. Torch and Rod Control
VI. Soldering with Filter Material
VII. Soldering a But Joint
VIII. Soldering in a Vertical Position

IMM-G3-LA
Perform Gas Soldering
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-G3-LW
Perform Gas Soldering
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate;
   Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate;
   Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

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INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-H1-HO
Maintain Air Conditioning Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wear rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how phychrometrics are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Reading Assignments:

The following chapters are assigned to read from ***Air Conditioning and Refrigeration Compressors,*** TPC Publishers, Latest Edition:

Lesson	Title
1	Compressors
4	Control and Protective Devices
5	Maintenance and Repair

Module Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation

IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems

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Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H1-LW
Maintain Air Conditioning Systems
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

2. Student will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

3. Instructor will grade students ability to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

IMM-H2-HO
Maintain Pneumatic Control Circuits
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:.
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Reading Assignments:

The following chapters are assigned to read from ***Fluid Power***, by Parker Publishers, Latest Edition:

Chapter	Title
5	Energy Transmission Using A Pneumatic System
11	Simple Pressure Control Valves

Module Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
  A. General
  B. Disassemble and rework
IX. Basic Circuit

IMM-H2-LA
Maintain Pneumatic Control Circuits
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H2-LW
Maintain Pneumatic Control Circuits
Attachment 3: **MASTER** Laboratory Worksheet

Practice Disassembling:

1. Shut-Off Valve
2. Check Valve
3. One-Way Valve
4. Two-Way Valve
5. Three-Way Valve
6. Four-Way Valve
7. Quick-Release Valve
8. Maintenance
   - A. General
   - B. Disassemble and rework
9. Basic Circuit

IMM-H3-HO
Troubleshoot Centrifugal Pumps
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal;
f. Demonstrate the installation of a centrifugal pump;
g. Set-up and operate a centrifugal pump safely;
h. Identify problems by troubleshooting centrifugal pumps;
i. Describe maintenance and repair of centrifugal pumps;
j. Demonstrate corrosion resisting centrifugal pumps; and,
k. Describe impeller design consideration.

Reading Assignments:

The following chapters are assigned to read from ***Pumps***, Stewart/Miller and Macmillian, Audel Publishing Company, Latest Edition:

Chapter	Title
2	Principles of Hydraulics
3	Centrifugal Pumps

Module Outline:

I. Describe the Principles of Hydraulics
   A. Introduction

- B. Basic principles
- C. Static head
- D. Static lift
- E. Displacement
- F. Buoyancy
- G. Hydrostatic paradox
- H. Hydrostatic balance

II. Describe Hydrodynamics and Water Flow
- A. Dynamic head
- B. Dynamic lift
- C. Total column
- D. Friction of water in pipes
- E. Measurement of water flow
- F. Siphon
- G. Flow through orifices
- H. Specific gravity
- I. Summary

III. Describe the Operation of a Centrifugal Pump
- A. Basic principles
- B. Straight vane pumps
- C. Curved vane pumps
- D. Volute (curve)
- E. Effects of the curvature

IV. Discuss the Classifications of Centrifugal Pump
- A. Single-stage
- B. Multistage
- C. Impellers
- D. Balancing

V. Identify and Describe the Parts of a Centrifugal Pump
- A. House or casting
- B. Impeller
- C. Stuffing box assembly
- D. Bearings and housing
- E. Shaft assembly
- F. Drive

VI. Demonstrate the Installation of a Centrifugal Pump
- A. Location
- B. Foundation
- C. Leveling-aligning
- D. Grouting
- E. Inlet pipe
- F. Discharge pipe
- G. High temperature material pumping

VII. Set-Up and Operate a Centrifugal Pump
- A. First check

1. Rotation
2. Lubrication
3. Bearing cooling water
4. Inspect all parts

B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations
A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head

IMM-H3-LA
Troubleshoot Centrifugal Pumps
Attachment 2: MASTER Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical object;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Set-up and operate a centrifugal pump;
   c. Troubleshoot a centrifugal pump;
   d. Stop the centrifugal pump;
   e. Disassemble, replace needed parts, reassemble the centrifugal pump;
   f. Reinstall the centrifugal pump;
   g. Operate and troubleshoot the centrifugal pump; and,
   h. Repeat steps a. through g. on other types of centrifugal pumps.

IMM-H3-LW
Troubleshoot Centrifugal Pumps
Attachment 3: MASTER Laboratory Worksheet

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1. Instructor will observe the safe and proper procedures for the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

2. Student will:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump;
   f. Operate and troubleshoot the centrifugal pump; and,
   g. Repeat steps a. through f. on other types of centrifugal pumps.

3. Instructor will grade student's performance on the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

IMM-H4-HO
Troubleshoot Positive Displacement Pumps
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Set-up and operate a positive displacement pump;
b. Troubleshoot a positive displacement pump;
c. Stop the positive displacement pump;
d. Disassemble, replace needed parts, reassemble the positive displacement pump;
e. Reinstall the positive displacement pump; and,
f. Operate and troubleshoot the positive displacement pump.

Reading Assignments:

The following chapters are assigned to read from ***Pumps (Audel)***, Stewart/Miller, Macmillian Publishing Company, Latest Edition

Chapter	Title
4	Rotary Pumps
5	Reciprocating Pumps
6	Special Service Pumps

Module Outline:

I. Describe the Principles of Operation of Rotary Pumps
   A. Gear-type pumps
   B. Vane-type pumps
   C. Piston-type pumps
II. Describe the Construction of Rotary Pumps

A. Gear-type pumps
B. Vane-type pumps
C. Piston-type pumps

III. Demonstrate the Installation and Operation of Rotary Pumps
A. Introduction of installation
B. Alignment
C. Drives for rotary gear pumps
D. Power for driving pumps
E. Piping
F. Direction of rotating
G. Starting and operating the pump
H. Practical installation
I. Types of gear pumps
J. Pressure relief valve

IV. Identify Problems in Troubleshooting Rotary Pumps
A. No liquid delivered
B. Insufficient liquid delivered
C. Pump delivers for a short period, then quits
D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency

IX. Identify and Describe Special Service Pumps
- A. Introduction to special service pumps
- B. Chemical and process pumps
- C. Pumps for handling of sewage
- D. Magma pumps
- E. Sump pumps
- F. Irrigation pumps
- G. Diaphragm type pumps
- H. Shallow and deep well pumps
- I. Turbine pumps
- J. Rubber impeller pumps
- K. Tubing pumps

IMM-H4-LA
Troubleshoot Positive Displacement Pumps
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop.
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H4-LW
Troubleshoot Positive Displacement Pumps
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

2. Student will:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

3. Instructor will grade the student's performance on:
   a. Set-up and operation of a positive displacement pump;
   b. Troubleshooting a positive displacement pump;
   c. Stopping the positive displacement pump;
   d. Disassembling, replacing needed parts, reassembling the positive displacement pump;
   e. Reinstalling the positive displacement pump; and,
   f. Operating and troubleshooting the positive displacement pump.

IMM-H5-HO
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain gate valve;
b. Maintain globe valve;
c. Maintain ball valve;
d. Maintain plug valve; and,
e. Maintain butterfly valve.

Reading Assignments:

The following chapters are assigned to read from *Piping Systems*, Schoolcraft Publishers, Latest Edition:

Chapter	Title
7	Common Valves

Module Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement

IMM-H5-LA
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking.

IMM-H5-LW
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

2. Student will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

3. Instructor will grade student's ability to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

IMM-H6-HO
Maintain Check Valves and Relief Valves
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participate in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain check valve; and,
b. Maintain relief valve.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems***, Schoolcraft Publishers, Latest Edition

Chapter	Title
7	Common Valves

Module Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement

IMM-H6-LA
Maintain Check Valves and Relief Valves
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H6-LW
Maintain Check Valves and Relief Valves
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

2. Student will demonstrate how to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

3. Instructor will grade student's ability to:
   Properly use check valve;
   Properly use relief valve;
   Maintain check valve;
   Maintain relief valve;
   Replace check valve; and,
   Replace relief valve.

IMM-H7-HO
Troubleshoot and Repair Blowers
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Troubleshoot blowers; and,
b. Repair blowers.

Reading Assignments:

The following chapters are assigned to read from *Industrial Motor Control,* Alerich, Delmar Publishers, Latest Edition:

Chapter	Title
48	Motor

Module Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers

IMM-H7-LA
Troubleshoot and Repair Blowers
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-H7-LW
Troubleshoot and Repair Blowers
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

2. Student will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

3. Instructor will grade student's ability to:
   Troubleshoot blowers; and,
   Repair blowers.

IMM-H8-HO
Troubleshoot, Maintain, and Repair Hydraulic Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Troubleshoot hydraulic system;
b. Maintain hydraulic system; and
c. Repair hydraulic system.

Reading Assignments:

The following chapters are assigned to read from ***Fluid Power 1,*** by Parker Publishers, Latest Edition:

Chapter	Title
3	Energy Transmission Using a Hydraulic System
4	Control of Hydraulic Energy
7	Hydraulic Pumps
8	Check Valves, Cylinders and Motors
10	Directional Control Valves
12	Pilot Operated Pressure Control Valves

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H8-LW
Troubleshoot, Maintain, and Repair Hydraulic Systems
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Student will practice:
   a. Troubleshooting hydraulic system;
   b. Maintaining hydraulic system; and,
   c. Repairing hydraulic system.

2. Instructor will grade student's performance.

IMM-H9-HO
Troubleshoot, Maintain, and Repair Pneumatic Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power 1*, by Parker Publisher, Latest Edition:

Chapters	Title
5	Energy Transmission Using A Pneumatic System
11	Simple Pressure Control Valves

Module Outline:

I. Pneumatic Theory
II. Compressor
III. Regulators
IV. Valves
V. Actuators
VI. Safety
VII. Prevention Maintenance
VIII. Troubleshooting Pneumatic Devices
IX. Repair Pneumatic Devices

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-H9-LW
Troubleshoot, Maintain, and Repair Pneumatic Systems
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Draw a circuit utilizing a single acting cylinder, gravity return, as the load. Use a directional control valve. Make the cylinder extend. Have the instructor approve the diagram. Construct the circuit. Have the instructor approve the circuit. Run the circuit.

2. Same as Problem #1, except use double acting cylinder.

3. Practice PM on an existing pneumatic system.. Instructor will go over typical PM procedures.

4. Same as Problem #1, except use meter-out circuit.

5. Same as Problem #1, except use a quick exhaust circuit.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

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INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-I1-HO
Maintain and Troubleshoot Belt Drive Systems
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Reading Assignments:

The following chapters are assigned to read from *Industrial Motor Control,* Alerich, Delmar Publishers, Latest Edition

Chapter	Title
60	Pulley Drives

Module Outline:

I. Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V. Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX. Belt Replacement

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-I1-LW
Maintain and Troubleshoot Belt Drive Systems
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

2. Student will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

3. Instructor will grade student's ability to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

IMM-I2-HO
Maintain and Troubleshoot Gear Power Transmission Drives
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
6	Gears

Module Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I2-LW
Maintain and Troubleshoot Gear Power Transmission Drives
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

2. Student will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

3. Instructor will grade student's ability to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

IMM-I3-HO
Maintain and Troubleshoot Chain Power Transmission Drives
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain chain power transmission drives; and,
b. Troubleshoot chain driven power transmission drives.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
7	Chain Drives

Module Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I3-LW
Maintain and Troubleshoot Chain Power Transmission Drives
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

2. Student will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

3. Instructor will grade student's ability to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

IMM-I4-HO
Maintain and Troubleshoot Clutches
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain clutches; and,
b. Troubleshoot clutches.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
3	Mechanical Power Transmission

Module Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly

IMM-I4-LA
Maintain and Troubleshoot Clutches
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-I4-LW
Maintain and Troubleshoot Clutches
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly
   - B. Troubleshoot:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly

2. Student will demonstrate how to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly
   - B. Troubleshoot:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch
     - (5) Pneumatic clutch
     - (6) Clutch-brake assembly

3. Instructor will grade student's ability to:
   - A. Maintain:
     - (1) Clutch
     - (2) Mechanical clutch
     - (3) Electrical clutch
     - (4) Hydraulic clutch

(5) Pneumatic clutch
(6) Clutch-brake assembly

B. Troubleshoot:
(1) Clutch
(2) Mechanical clutch
(3) Electrical clutch
(4) Hydraulic clutch
(5) Pneumatic clutch
(6) Clutch-brake assembly

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

1250

Duty1

1251

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-J1-HO
Layout Sheet Metal Parts
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal sizes and products;
b. Describe sheet metal patterns and patternmaking; and,
c. Describe sheet metal and wire size.

Reading Assignments:

The following chapters are assigned to read from ***Metal Technology and Practice***, Pepp/MeCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

Chapters	Title
8	Sheet Metal Processing

Module Outline:

I. Identify Sheet Metal Sizes and Products
   A. Sizes
   B. Products
II. Describe Sheet Metal Patterns and Patternmaking
   A. Introduction
   B. Types of pattern development
   C. Hem and seam allowances on patterns
   D. Bending sequence
   E. Bend allowance
III. Describe Sheet Metal and Wire Sizes

A. Sheet metal and wire gages
B. Manufacturers' standard gages and sheet steel
C. Brown and Sharp or American Standard gage

IMM-J1-LA
Layout Sheet Metal Parts
Attachment 2: **MASTER** Laboratory Aid

1. Instructor will:
   a. Demonstrate the proper layout procedures for sheet metal layout;
   b. Insure proper tools are availble for layout;
   c. Insure proper tools are construction of project are available;
   d. Insure proper techniques are used for layout; and,
   e. Insure proper techniques are used in safely constructing the projects.

2. Student will:
   a. Layout and construct sheet metal patterns on paper;
   b. Practice making parallel line pattern of a rectangular pan;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   c. Practice making parallel line development for a cylinder;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   d. Practice making parallel line development of a truncated cylinder;
      (1) Use necessary drawing tools; and,
      (2) Use necessary tools and materials for a safe assembly.

SHEET METAL AND WIRE GAGE DESIGNATION

GAGE NO.	AMERICAN OR BROWN & SHARPE'S A.W.G. OR B&S	UNITED STATES STANDARD	MANUFACTURERS' STANDARD FOR SHEET METAL	GAGE NO.
0000000	....	.500	....	0000000
000000	.5800	.469	....	000000
00000	.5165	.438	....	00000
0000	.4600	.406	....	0000
000	.4096	.375	....	000
00	.3648	.344	....	00
0	.3249	.312	....	0
1	.2893	.281	....	1
2	.2576	.266	....	2
3	.2294	.250	.2391	3
4	.2043	.234	.2242	4
5	.1819	.219	.2092	5
6	.1620	.203	.1943	6
7	.1443	.188	.1793	7
8	.1285	.172	.1644	8
9	.1144	.156	.1495	9
10	.1019	.141	.1345	10
11	.0907	.125	.1196	11
12	.0808	.109	.1046	12
13	.0720	.0938	.0897	13
14	.0642	.0781	.0747	14
15	.0571	.0703	.0673	15
16	.0508	.0625	.0598	16
17	.0453	.0562	.0538	17
18	.0403	.0500	.0478	18
19	.0359	.0438	.0418	19
20	.0320	.0375	.0359	20
21	.0285	.0344	.0329	21
22	.0253	.0312	.0299	22
23	.0226	.0281	.0269	23
24	.0201	.0250	.0239	24
25	.0179	.0219	.0209	25
26	.0159	.0188	.0179	26
27	.0142	.0172	.0164	27
28	.0126	.0156	.0149	28
29	.0113	.0141	.0135	29
30	.0100	.0125	.0120	30
31	.0089	.0109	.0105	31
32	.0080	.0102	.0097	32
33	.0071	.00938	.0090	33
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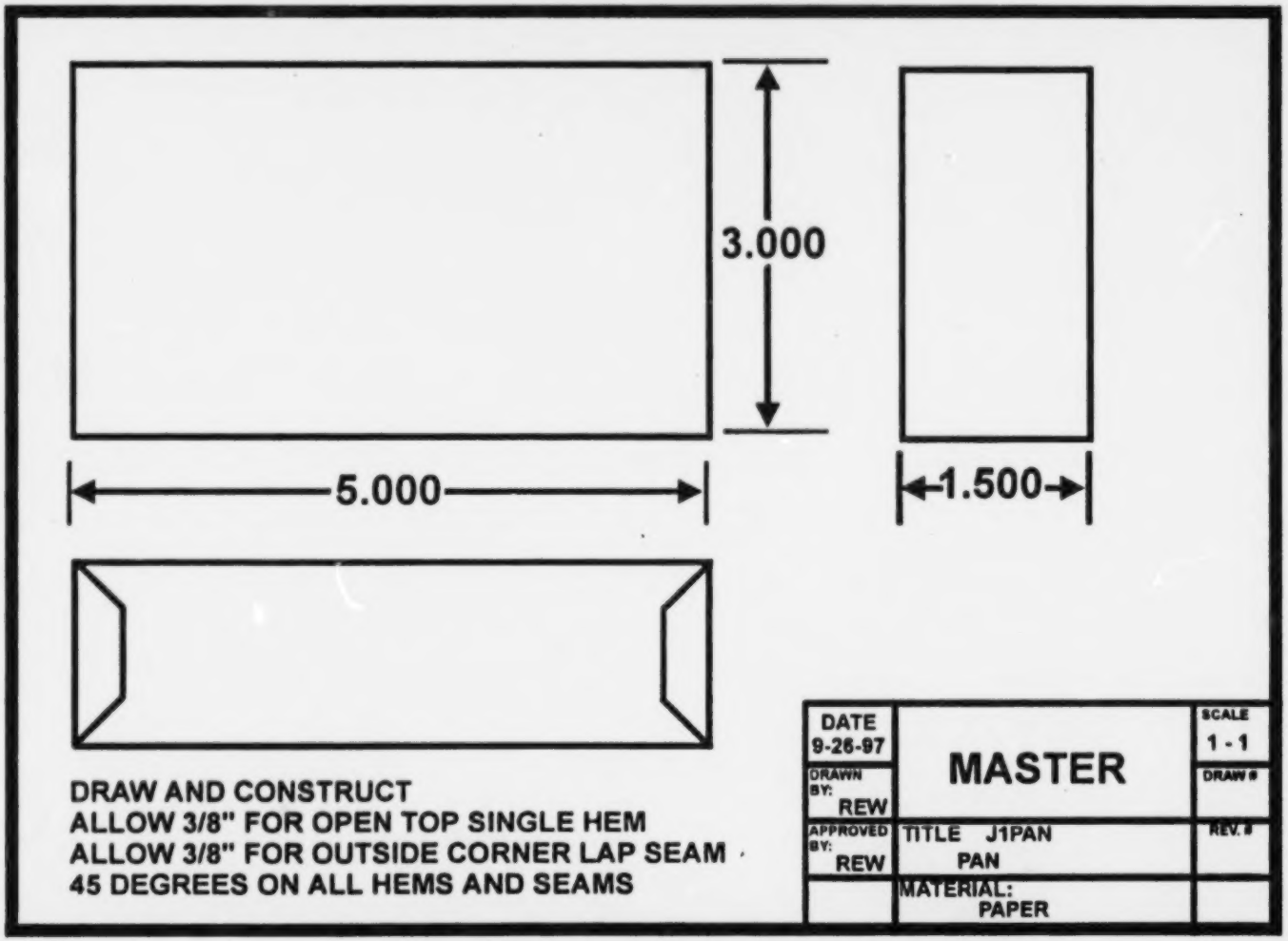
35	.0056	.00781	.0075	35
36	.0050	.00703	.0067	36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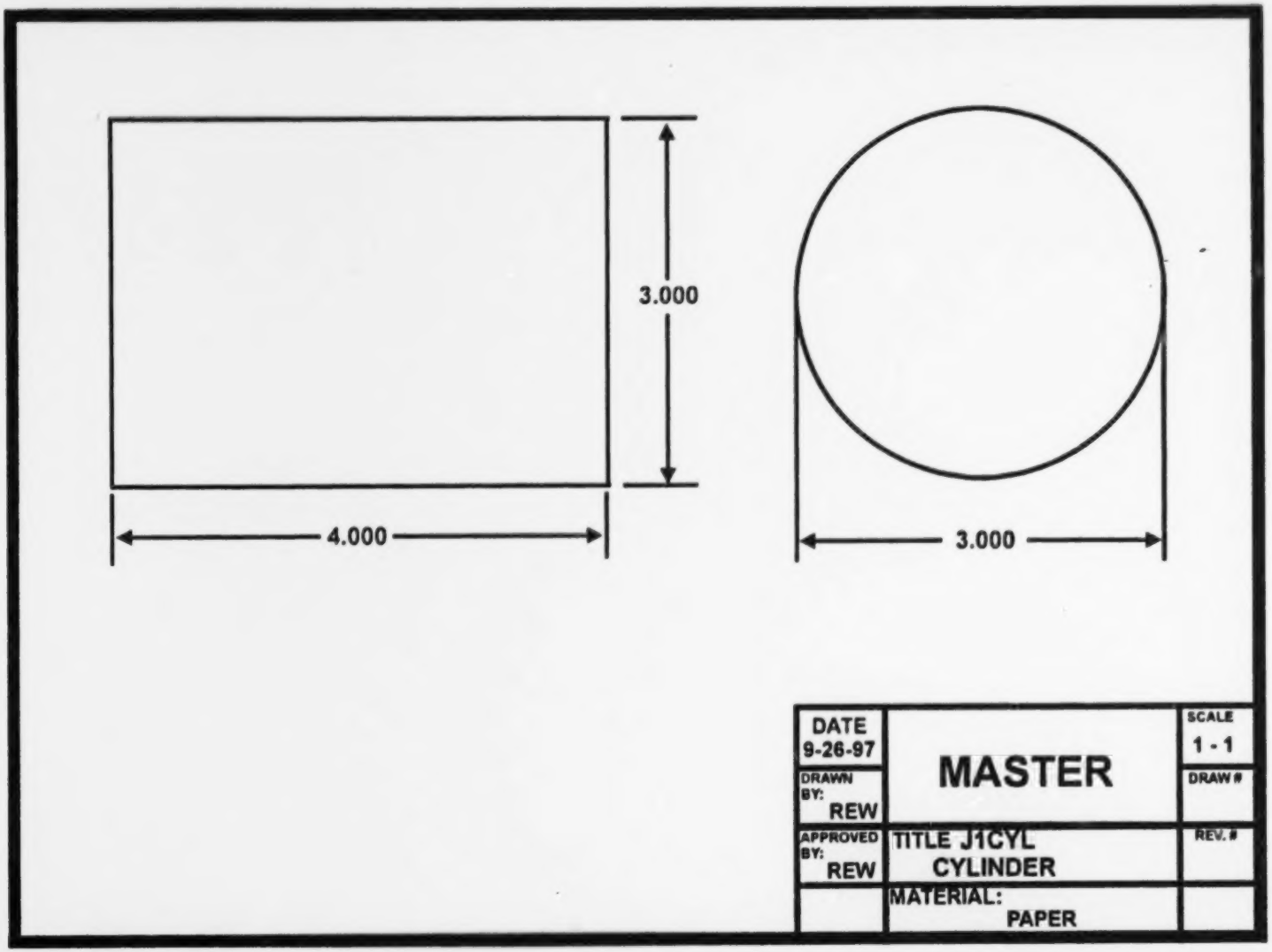
DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS
DATE
9-26-97
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
SCALE
1 - 1
DRAW #
REV. #
TITLE J1PAN
PAN
MATERIAL:
PAPER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DRAWN BY:
REW
APPROVED BY:
REW
MASTER
SCALE
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DRAW #
TITLE J1CYL
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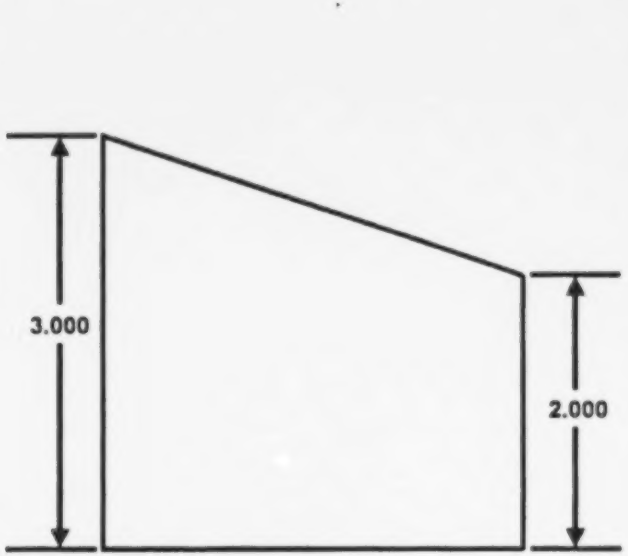
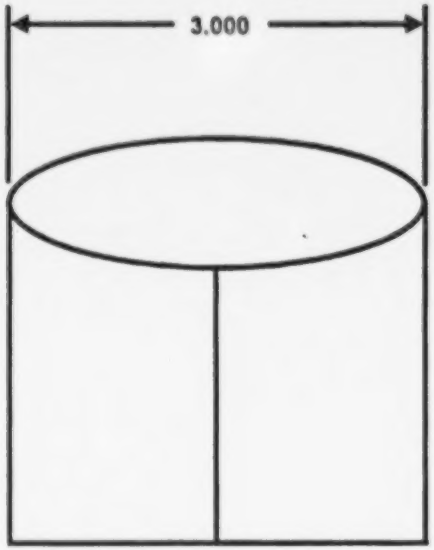
MATERIAL:
PAPER





DRAW AND CONSTRUCT
NO TOP OR BOTTOM
ALLOW 3/8" FOR LAP SEAM

DATE 9-26-97	MASTER	SCALE 1 - 1
DRAWN BY: REW		DRAW #
APPROVED BY: REW	TITLE J1TRUNCY TRUNCATED CYLINDER	REV. #
	MATERIAL: PAPER	

IMM-J2-HO
Form and/or Bend Sheet Metal Parts
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work Technology and Practice,*** Repp/McCarthy, Glencoe/Mcmillian/McGraw-Hill Publishers, Latest Edition:

Chapters	**Title**
8	Sheet Metal Processing

Module Outline:

I. Identify Sheet Metal Hand Tools
   A. Layout blue and removers
   B. Layout tools
   C. Hammers
   D. Pliers
   E. Hand seamers
   F. Hand groovers

II. Describe Sheet Metal Cutting Tools
   A. Hand hole punches
   B. Turret punch
   C. Tin snips
   D. Aviation snips
   E. Double-cutting shear
   F. Squaring shear
   G. Notcher
   H. Ring and circle shear
   I. Lever shear
   J. Electric and pneumatic nibblers and sheers

III. Set-up and Operate Sheet Metal Bending Machines
   A. Bar folder
   B. Cornice brake
   C. Press brake
   D. Box and pan brake

IV. Set-up and Operate Sheet Metal Tools Forming of Cylindrical Parts
   A. Slip roll forming machine
   B. Turning machines and wiring machine
   C. Burring, setting down and double seaming machines
   D. Crimping and beading machines
   E. Grooving machines
   F. Pittsburgh lock forming machines

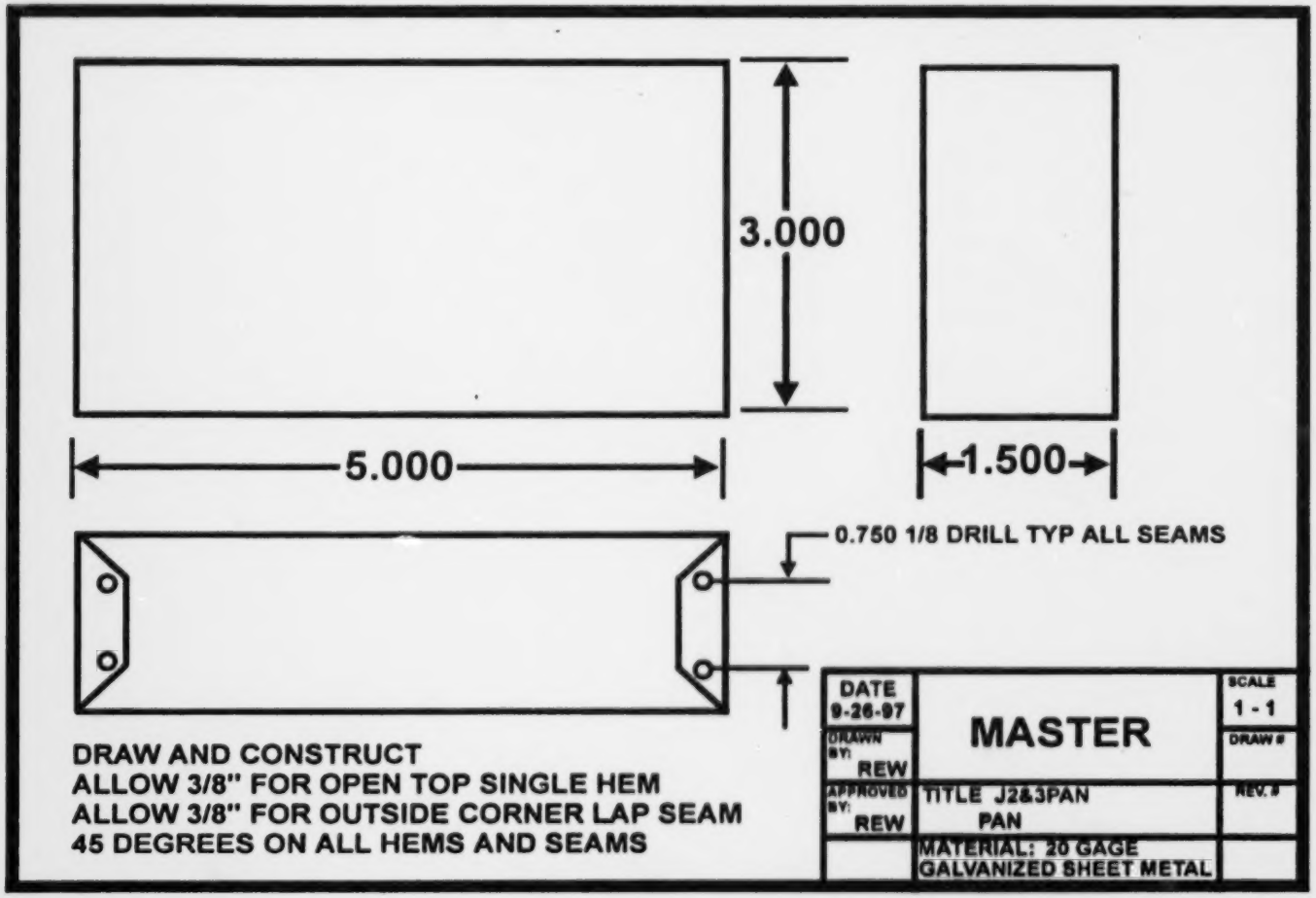
V. Demonstrate Sheet Metal Hand Bending Stakes
   A. Bench plate
   B. Double seaming stake
   C. Beakhorn stake
   D. Bevel-edge square stake
   E. Hatchet stake
   F. Needle-case stake
   G. Blowhorn stake
   H. Hollow mandrel stake

IMM-J2-LA
Form and/or Bend Sheet Metal Parts
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to construct the pan project;
   b. Insure proper tools and materials are available for the pan project;
   c. Proper techniques are used in layout; and,
   d. Proper techniques and safety procedures are followed in construction of the pan project.

2. Student will:
   a. Layout and construct sheet metal pan project;
   b. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures;
   c. Cut the pan layout to proper size and shape using the proper cutting tools;
   d. Bend the pan project using the proper machines and procedures safely; and,
   e. Safely punch or drill the holes using the proper procedures.


3.000
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0.750 1/8 DRILL TYP ALL SEAMS
DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS
DATE
9-26-97
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
TITLE J2&3PAN
PAN
MATERIAL: 20 GAGE
GALVANIZED SHEET METAL
SCALE
1 - 1
DRAW #
REV. #

IMM-J3-HO
Fasten Sheet Metal Parts Together
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Reading Assignments:

The following chapters are assigned to read from ***Metal Technology and Practice,*** Repp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

Chapters	**Title**
7	Fitting and Assembling

Module Outline:

I. Identify Sheet Metal Self Threading Screws
   A. Thread forming screws
   B. Thread cutting screws
   C. Head styles used on threaded fasteners
   D. Driver recesses used on screw heads
   E. Drive screw
II. Describe Rivets and Riveting
   A. Introduction
   B. Riveting

C. Rivet size
D. Tinners rivets
E. Choosing a rivet
F. Rivet spacing
G. The rivet set
H. How to rivet
I. Hot and cold rivets
J. Removing rivets
K. Tubular and special rivets
L. Blind rivets

III. Demonstrate Soldering Sheet Metal
A. Introduction to soldering
B. Soft soldering
C. Heat for soft soldering
D. Soldering copper
E. Tin a soldering copper
F. Preparing the workpiece
G. Joints for soft soldering
H. Soft soldering techniques
I. Hard soldering techniques

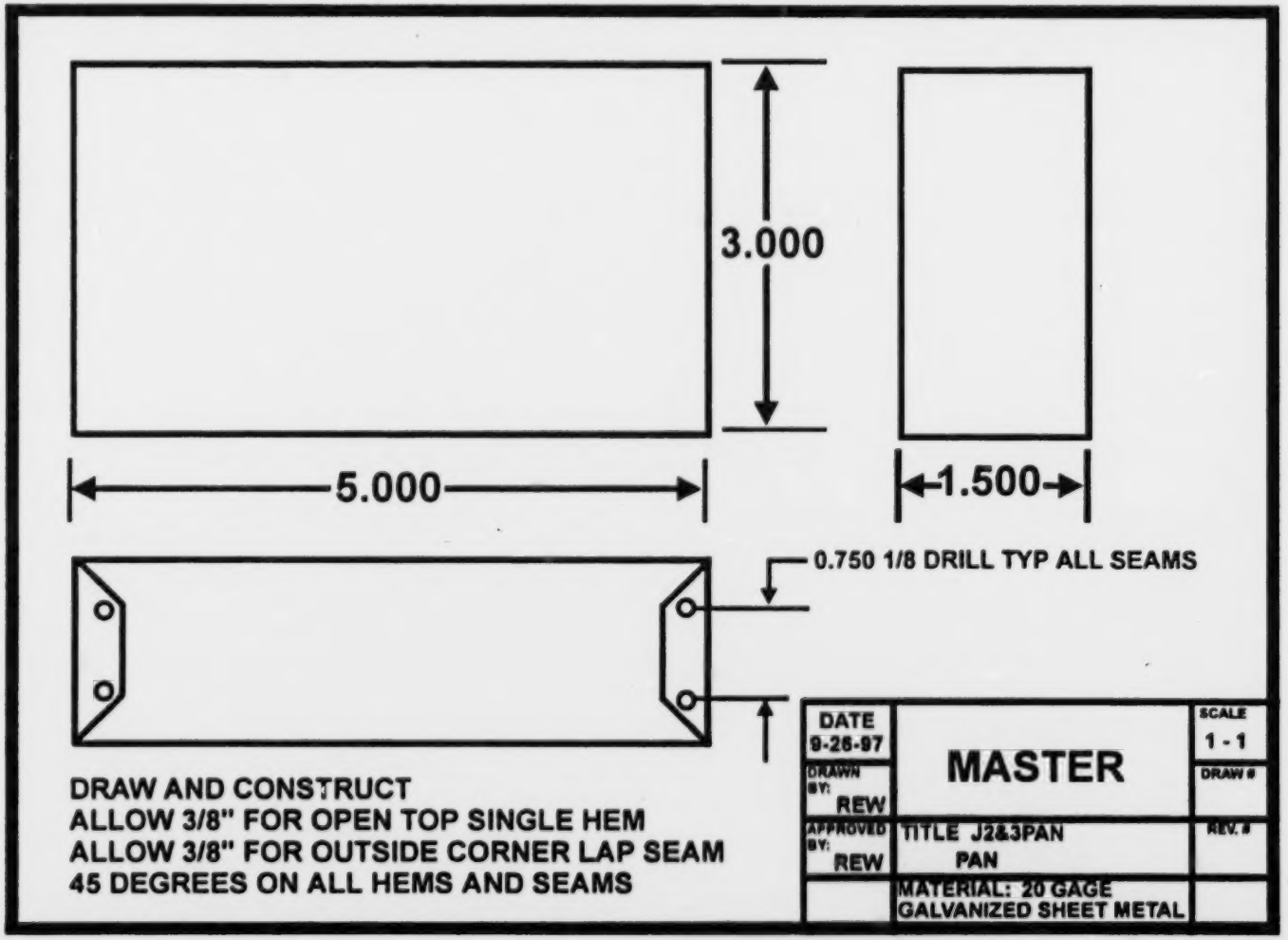
IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal
A. Introduction
B. Difference between brazing and braze welding
C. Brazing and braze welding fluxes
D. Rods for brazing and braze welding
E. How to braze with a torch

IMM-J3-LA
Fasten Sheet Metal Parts Together
Attachment 2: MASTER Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to assemble sheet metal parts;
   b. Insure proper tools and materials are available for projects; and,
   c. Proper techniques and safety procedures are followed in constructing projects.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the projects;
   b. Secure sheet metal using self threading screws;
   c. Secure sheet metal using rivets and riveting;
   d. Secure sheet metal using soldering;
   e. Secure sheet metal using brazing; and,
   f. Secure pan project using pop rivets.


3.000
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DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
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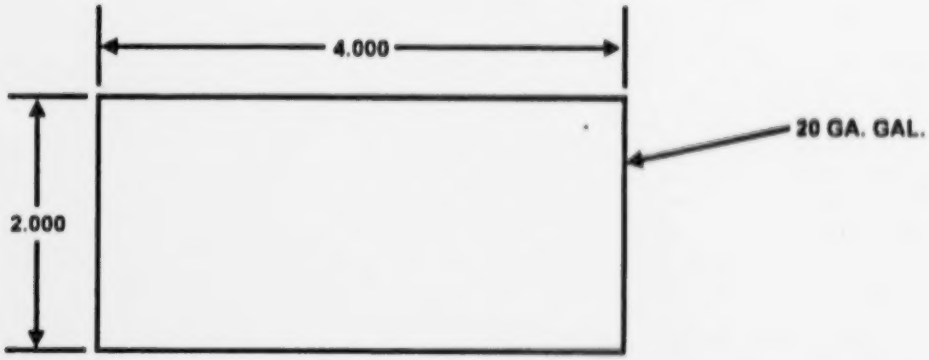
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
SCALE
1 - 1
DRAW #
REV. #
TITLE J2&3PAN
PAN
MATERIAL: 20 GAGE
GALVANIZED SHEET METAL



ASSEMBLE 2 EA. WITH SELF THREADING SCREWS
ASSEMBLE 2 EA. WITH RIVETS
ASSEMBLE 2 EA. BY SOLDERING
ASSEMBLE 2 EA. BY BRAZING

DATE 9-26-97	MASTER	SCALE 1 - 1
DRAWN BY: REW		DRAW #
APPROVED BY: REW	TITLE J3THRIV THREAD AND RIVET PLT.	REV. #
	MATERIAL: 20 GAGE GALVANIZED SHEET METAL	

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
A	Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B	Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C	Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D	Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E	Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F	Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G	Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H	Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I	Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J	Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

1276

Duty K

1277

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-K1-HO
Perform Basic Pipefitting Calculations
Attachment 1: MASTER Handout

Standards of performance:

Student will demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Reading Assignments:

The following chapters are assigned to read from ***Millwright's Handbook***, Audel Publishers, Latest Edition:

Chapters	Title
14	Fittings

Module Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   A. Run
   B. Set
   C. Travel
   D. Offset
II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
   A. Obstructions to be worked around

1. Other pipe
2. Wall
3. Equipment

III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter

A. Center line measurements. (point to point)

B. Simple offset

1. Using table of multipliers for calculating simple offsets
2. Discuss the concept that an offset is nothing more than the missing side of a right triangle

C. Equal spread offset

1. Two-pipe spread using 22-1/2 degree threaded fittings
2. Review formula and tables from pipe fitting hand book

D. Rolling offset

1. Use of trigonometric tables in calculation of rolling offset
2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"

IMM-K2-HO
Cut, Thread, and Ream Pipe
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify two methods of cutting, reaming and threading pipe;
b. Identify equipment required to cut, thread and ream pipe;
c. Describe the use and care of equipment required when cutting, threading and reaming pipe;
d. Identify safety concerns that apply to use of cutting, threading and reaming equipment; and,
e. Fabricate from pipe stock, a NPT threaded nipple that is cut, square and properly reamed.

Module Outline:

I. Identify Safety Concerns That Apply to Use of Cutting, Threading and Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles
II. Practice Hand Cutting, Reaming and Threading Pipe
III. Practice Using the Electric Pipe Cutting, Threading and Reaming Equipment
IV. Practice Fabricating from Pipe Stock, Using a NPT Threaded Nipple That Is Cut Square and Properly Reamed

IMM-K2-LA
Cut, Thread, and Ream Pipe
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

IMM-K2-LW
Cut, Thread, and Ream Pipe
Attachment 3: **MASTER** Laboratory Worksheet

Practice:

1. Identifying methods of cutting, reaming and threading pipe.

   _____

   _____

2. Identify equipment required to cut thread and ream pipe.

   _____

   _____

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

   _____

   _____

4. Demonstrate how to fabricate from pipe stock.

   _____

   _____

5. Demonstrate how a NPT threaded nipple is cut.

   _____

   _____

6. Demonstrate how to square and properly ream a NPT threaded nipple.

_____

_____

Instructor will use the following to generate a practical exam:

1. Identify two methods of cutting, reaming and threading pipe.

_____

_____

2. Identify equipment required to cut thread and ream pipe.

_____

_____

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

_____

_____

4. Demonstrate how to fabricate from pipe stock, a NPT threaded nipple that is cut square and properly reamed.

_____

_____

IMM-K3-HO
Pipe Assembly
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Reading Assignments:

The following chapters are assigned to read from ***Millwrights' Handbook***, Audel Publishers, Latest Edition:.

Chapters	**Title**
14	Fittings

Module Outline:

I. Identify Two Types of Threaded Companion Flanges
   A. Standard
   B. Heavy
II. Identify Typical Materials from Which Threaded Flanges Are Made
   A. Iron
   B. Cast Iron
   C. Stainless Steel
   D. Various types of plastic

III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
   A. Apply pipe compound appropriate for the system to the pipe threads
   B. Install first flange half snug but not tight
   C. Install last flange half snug
   D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
   A. Sharp threads
   B. Heavy components in awkward positions
   C. Heavy gloves
   D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket type and position

IMM-K3-LA
Pipe Assembly
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-K3-LW
Pipe Assembly
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Practice identifying types of threaded companies flanges.
2. List materials that threaded flanges are made up of.
3. List steps to assemble threaded flanges.
4. Assemble a threaded flange.
5. List safety concerns when assembling a threaded flange.

IMM-K4-HO
Install and Adjust Pipe Support
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of pipe supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Reading Assignments:

The following chapters are assigned to read from ***Basic Plumbing***, Harry Slater & Lee Smith, Delmar Publishers, Latest Edition:

Section	Unit
5-Plumbing Hardware	28-Pipe Hangers
5-Plumbing Hardware	29-Fastenings

Module Outline:

I. Describe the Purpose of Pipe Supports
   A. Position
   B. Materials the support may be attached to
   C. Reasons for pipe supports
II. Identify the Types of Pipe Supports
   A. Reznor hook
   B. Pipe strap
   C. Perforated iron strap
   D. Clevis hanger

E. F&M hanger
F. Coil hanger
G. Spring cushion
H. Special hangers
I. Split ring hanger

III. Describe the Distance Between Hangers
A. Type of pipe
B. Type of joints

IV. Identify the Pipe Support Fastener
A. Fastening to different materials
B. The type and procedure for each fastener

IMM-K4-LA
Install and Adjust Pipe Support
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Support the side of the piping project to a vertical wood 2x4 using proper hardware; and,
   c. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.

IMM-K4-LW
Install and Adjust Pipe Support
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

2. Student will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

3. Instructor will grade student's ability to:
   a. Install pipe supports; and,
   b. Adjust pipe supports.

IMM-K5-HO
Tubing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL 60089, 1-800-837-1255, Latest Edition:

Chapter	Title
4	Tubing

Module Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing
II. Demonstrate How to Join Tubing
   A. Cutting
   B. Deburring
   C. Soldering
   E. Flared and ferrule fittings
   E. Bending

III. Identify Types of Tubing
   A. Copper
   B. Steel
   C. Aluminum
   D. Plastic
   E. Other applications
IV. Describe Tubing Maintenance
   A. Check system
   B. Repair system

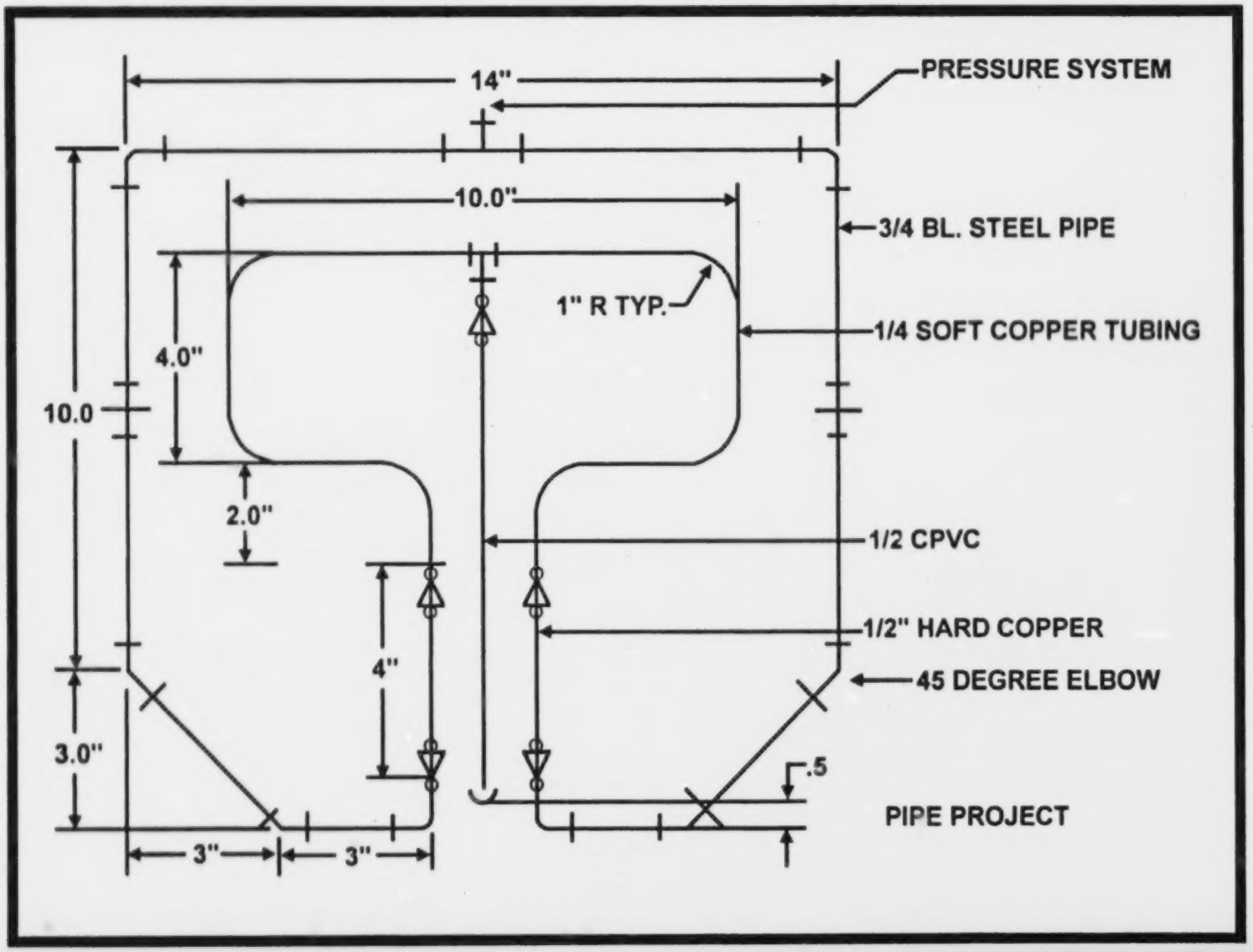
IMM-K5-LA
Tubing
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Cut type M rigid copper tubing;
   c. Debur solder proper fittings to type M rigid 1/2 inch copper tubing;
   d. Bend, cut, and debur 1/4 inch soft copper tubing; and,
   e. Flair one end and use a ferrule on the tee end of 1/4 inch soft copper tubing.

IMM-K5-LW
Tubing
Attachment 3: MASTER Laboratory Worksheet



IMM-K6-HO
Fittings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL. 60089, 1-800-837-1255, Latest Edition:

Chapter	Title
6	Fittings

Module Outline:

I. Describe the Purpose of Fittings
   A. Connect sections
   B. Change the flow
   C. Pipe and tubing
II. Identify the Function of Fittings
   A. Change the direction of flow
   B. Providing branch connections
   C. Change line size
   D. Caps, plugs and couplings

III. Demonstrate How Fittings Are Connected
   A. Screwed
   B. Flanged
   C. Welded
   D. Tubing
IV. Identify Drawing Symbols
   A. Flanged
   B. Screwed
   C. Welded
   D. Bell and spigot
   E. Soldered

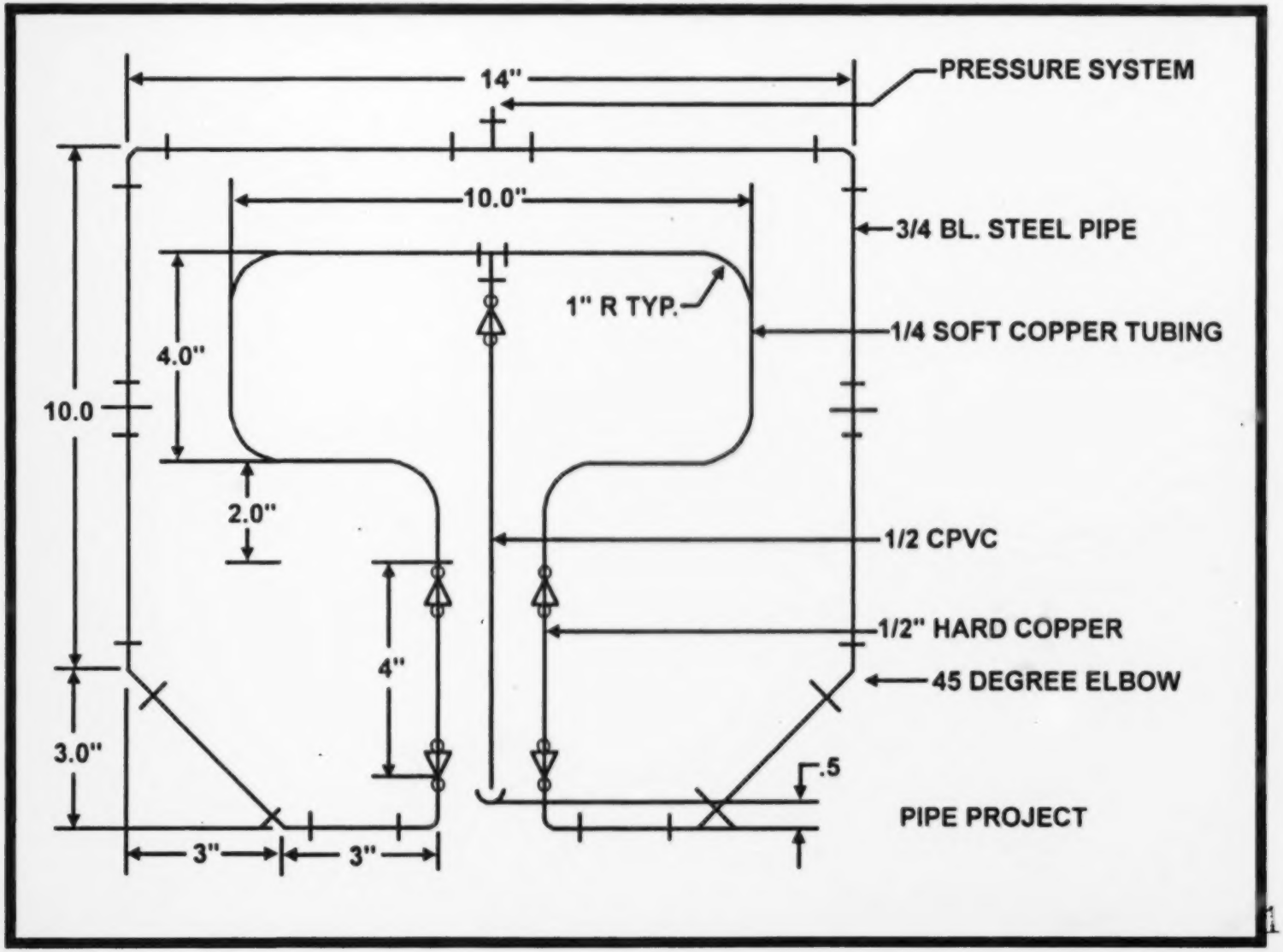
IMM-K6-LA
Fittings
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join pipe in piping project;
   c. Join copper tubing by soldering in piping project;
   d. Join copper tubing with fittings, ferrule and flare in piping project; and,
   e. Join plastic tubing in piping project.

IMM-K6-LW
Fittings
Attachment 3: **MASTER** Laboratory Worksheet



IMM-K7-HO
Plastic Pipe
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Reading Assignments:

The following chapters are assigned to read from ***Piping Systems, Mechanical Equipment Series 736,*** Schoolcraft Publishing, Latest Edition

Chapter	Title
3	Plastic Piping

Module Outline:

I. Describe Plastic Pipe
   A. Advantages
   B. Thermoplastic piping
   C. Thermosetting plastics
   D. Limitations
II. Demonstrate Joining Plastic Pipe
   A. Welding
   B. Threaded joints
III. Identify Plastic Pipe Maintenance Procedures
   A. Identify
   B. Repair

IMM-K7-LA
Plastic Pipe
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join a coupling to plastic pipe by solvent welding;
   c. Install a cap to CPVC by solvent welding; and,
   d. Install plastic pipe to pipe project.

IMM-K7-LW
Plastic Pipe
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

2. Student will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

3. Instructor will grade student's ability to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Tasks →

Duties													
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe					
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills										
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings										
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations										
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment										
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings								
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices							
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power							
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique					

IMM-L1-HO
Rigging Fundamentals
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide***, Anderson, Audel Publishers, Latest Edition:

Chapters	Title
21	Rigging

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

IMM-L2-HO
Demonstrate Basic Rigging Skills
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage;
d. List two ways to construct a sling; and,
e. Demonstrate basic rigging skills.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Anderson, Audel Publishers, Latest Edition::

Chapters	Title
21	Rigging

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

IMM-L2-LA
Demonstrate Basic Rigging Skills
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-L2-LW
Demonstrate Basic Rigging Skills
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

2. Student will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

3. Instructor will grade student's ability to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties		Tasks												
K	Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L	Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M	Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N	Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O	Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P	Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q	Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R	Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S	Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-M1-HO
Plain Bearings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, ISBN 0170087050, Delmar/I.T.P., Latest Edition:

Chapter	Title
6.1	Plain Bearings

Module Outline:

I. Describe the Principles of Plain Bearings
   A. Introduction of bearings
   B. Lubrication
   C. Reason for soft bearing materials
II. Identify the Types and Materials of Plain Bearings
   A. Journal bearings
   B. Thrust bearings
   C. Linear bearings
   D. Material characteristics

E. Material types and uses

III. Demonstrate Maintenance Practices for Plain Bearings
- A. General
- B. Assembly
- C. Cleaning
- D. Relining journal bearings
- E. Start-up

IV. Identify Failure Patterns of Plain Bearings
- A. Operating symptoms
- B. Symptoms found on inspection
- C. Causes of failure

IMM-M1-LA
Plain Bearings
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install shaft in two plain pillows block bearings;
   c. Align, secure bearings to table and secure shaft to bearings;
   d. Remove old bearing and press plain bearing in housing using proper tools and procedures;
   e. Check inside diameter and shaft for proper fit;
   f. Hone to size if necessary;
   g. Lubricate bearings; and,
   h. Run and troubleshoot bearing and shaft assemblies.

IMM-M1-LW
Plain Bearings
Attachment 3: **MASTER** Laboratory Worksheet

Review the general section under maintenance practices pages of text (reading assignment) prior to performing practical applications.

IMM-M2-HO
Rolling Element Bearings
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance,*** Dick Jeffrey, Delmar/ITP Publishing, Latest Edition

Chapter	Title
6.2	Rolling Element Bearings

Module Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   A. Introduction
   B. Ball bearings
   C. Roller bearings
   D. Linear bearings
II. Identify the Types of Rolling Elements Bearings
   A. Journal bearings
   B. Thrust bearings

III. Describe Roller Element Bearing Assembly Design
- A. Shaft and housing fits
- B. Thermal expansion
- C. Types of mountings

IV. Demonstrate Maintenance Practices of Roller Element Bearings
- A. General
- B. Tools and equipment
- C. Mounting procedures
- D. Pre-lubrication
- E. Selection of mounting method
- F. Special considerations
- G. Dismounting procedures

V. Identify Failure Patterns of Rolling Element Bearings
- A. Operating symptoms
- B. Symptoms found on inspection
- C. Cause of failure

IMM-M2-LA
Rolling Element Bearings
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install a shaft in two self aligning pillow block bearing with rolling element bearings;
   c. Change the rolling element bearing in a self aligning pillow block to a different size;
   d. Remove a rolling element bearing from a shaft and install another bearing;
   e. Remove a rolling element bearing form a housing and install another bearing; and,
   f. Clean and pre-lubricate a rolling element bearing.

IMM-M2-LW
Rolling Element Bearings
Attachment 3: **MASTER** Laboratory Worksheet

Review the general section, under maintenance practices pages of text (reading assignment) prior to performing practical applications.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

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IMM-N1-HO
Perform Basic Word Processing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the computer laboratory by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Create a document;
b. Edit a document;
c. Select fonts;
d. Cut, copy, and paste;
e. Select tab and indent;
f. Get help;
g. Use speller and thesaurus;
h. Find and replace;
i. Create header and footer;
j. Create tables;
k. Use columns; and,
l. Import and export graphics.

Reading Assignments:

The following chapters are assigned to read from *Learning WordPerfect* by Corel Corp., Latest Edition:

Section	Title
1	Creating a Document
1	Editing a Document
1	Selecting Fonts
1	Using Cut, Copy, and Paste
2	Using Tab and Indent
2	Using Help
3	Using Speller and Thesaurus
3	Find and Replace
3	Headers and Footers
3	Tables
4	Columns
4	Graphics

Module Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics

The students will:

a. Follow housekeeping rules set up by instructor and school;
b. Follow closely instructions given by instructor;
c. Do not go faster than instructor, this could create problems;
d. If unable to follow instructor, let instructor know; and,
e. Ask questions if steps are not clear.

IMM-N1-LW
Perform Basic Word Processing
Attachment 3: **MASTER** Laboratory Worksheet

The students will:

a. Practice using software commands;
b. After practicing setting up spreadsheet, proceed to creating charts; and,
c. After practicing creating charts, let instructor know that you are ready to take performance measure.

IMM-N2-HO
Perform Basic Spreadsheet Operations
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the computer lab.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Reading Assignments:

The following chapters are assigned to read from *PFS: Window Works* by Spinnaker Publishing Co., Latest Edition:

Chapters	Title
11	File Menu Commands
11	Edit Menu Commands
11	Format Menu Commands
11	Create Chart

Module Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet

IMM-N2-LA
Perform Basic Spreadsheet Operations
Attachment 2: **MASTER** Laboratory Aid

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1. Follow housekeeping rules set up by instructor and school;
2. Follow closely instructions given by instructor;
3. Do not go faster than instructor; this could create problems;
4. If unable to follow instructor, let instructor know; and,
5. Ask questions if steps are not clear.

IMM-N2-LW
Perform Basic Spreadsheet Operations
Attachment 3: **MASTER** Laboratory Worksheet

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1. Practice using software commands;
2. After practicing setting up spreadsheet, proceed to creating charts; and,
3. After practicing creating charts, let instructor know that you are ready to take Self-Assessment.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-O1-HO
Principles of Alignment
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe misalignment;
b. Identify tolerances for alignment;
c. Describe adjustments procedures;
d. Demonstrate how to align using a dial indicators;
e. Describe thermal growth; and,
f. Demonstrate doweling after alignment.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operations and Maintenance***, Dick Jeffrey, Delmar Publishing/ATP, Latest Edition:

Chapter	Title
8	Shaft Alignment

Module Outline:

I. Describe Misalignment
   A. Parallel misalignment
   B. Angular misalignment
   C. Combination misalignment
II. Identify Tolerances for Alignment
   A. Coupling manufacturers
   B. Machinery manufacturers

C. Special conditions

III. Describe Adjustment Procedures
- A. Unit to adjust
- B. Distance and soft foot
- C. Equipment rocking (soft-foot)
- D. Vertical alignment first

IV. Determine How to Align Using a Dial Indicator
- A. Introduction to a dial indicator
- B. Total indicator run-out

V. Describe Thermal Growth
- A. Effects of temperature
- B. Aligning steam turbines

VI. Demonstrate Doweling after Alignment
- A. Purpose
- B. Location

IMM-O1-LA
Principles of Alignment
Attachment 2: **MASTER** Laboratory Aid

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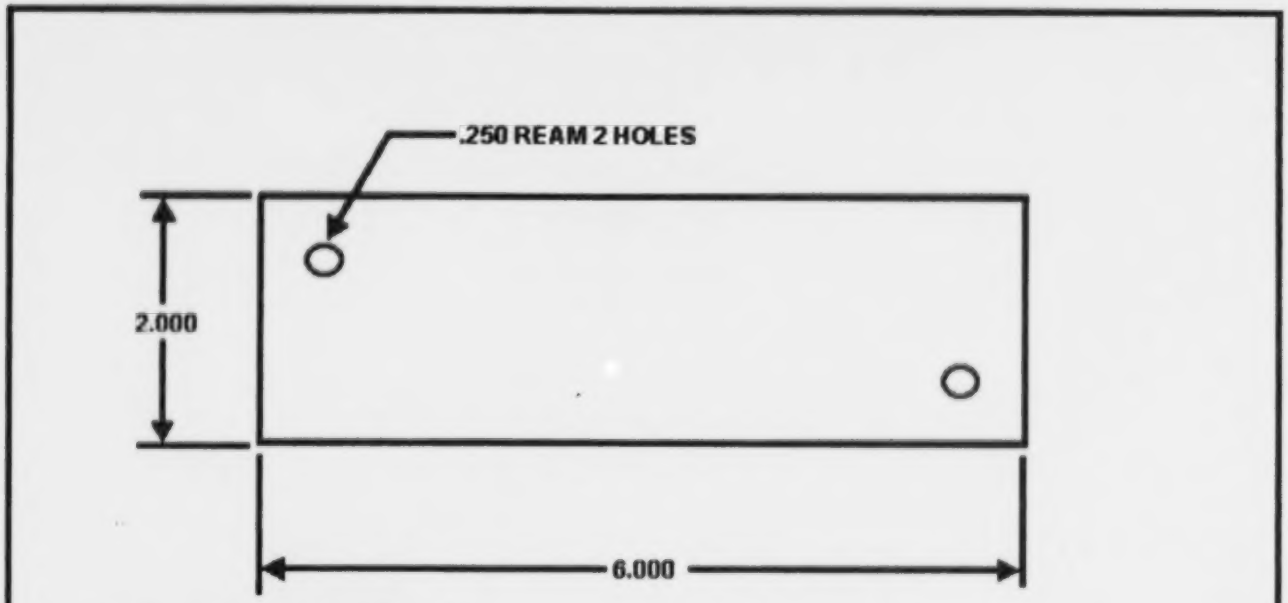
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
   c. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.



2 ea. Plates, drill, ream and dowel
Use 2 ea. 1/4" X 1/2" dowel pins

TITLE DOWELP-1 COUPLING ALIGNMENT			AMTEC A DIVISION OF AUGUSTA TECH 3116 DEANS BRIDGE RD. AUGUSTA, GA 30906 USA	MATERIAL STEEL			
DATE	DRAWN BY: REW	APPROVED BY: RDW			SCALE 1-1	DRAWN O-1	REVN

IMM-O2-HO
Methods of Alignment
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operations and Maintenance,*** Dick Jeffrey, Delmar Publishing, ATP, Latest Edition:

Chapter	Title
8	Shaft Alignment

Module Outline:

I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
   B. Parallel misalignment
   C. Tolerances
II. Describe the Face and Rim Method of Aligning Couplings
   A. Introduction
   B. Short comings
III. Set-Up and Align Couplings Using the Reve se Indicator Method
   A. Advantages of

B. Procedures for aligning

IV. Describe the General Hints on Alignment

A. Measuring tools and shims

B. Equipment

IMM-O2-LA
Methods of Alignment
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Align a coupling using the straight edge and feeler gage method; and,
   c. Align a coupling using dial indicators.

IMM-O2-LW
Methods of Alignment
Attachment 3: **MASTER** Laboratory Worksheet

Review:

a. General hints on alignment; and,
b. Pages in textbook on alignment.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacety lene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Trouble-shoot centrifugal pumps	H-4 Trouble-shoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Trouble-shoot and repair blowers	H-8 Trouble-shoot, maintain, and repair hydraulic systems	H-9 Trouble-shoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and ratio	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-P1-HO
Install Electrical Connections
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Reading Assignments:

The following chapters are assigned to read from ***Westinghouse Electrical Maintenance Hints***, Westinghouse Electrical Corporation, publishers, Latest Edition:

Chapters	Title
4	Cable Contraction and Application
41	Insulation Materials

Module Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques

IMM-P1-LA
Install Electrical Connections
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-P1-LW
Install Electrical Connections
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

2. Student will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

3. Instructor will grade students ability to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

IMM-P2-HO
Setting and Leveling
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the importance of setting and leveling machinery;
b. Identify shim shapes and locations; and,
c. Demonstrate the procedures for setting and leveling machines.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ATP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe the Importance of Setting and Leveling Machinery
   A. Bedplate
   B. Foundation
II. Identify Shim Shapes and Locations
   A. Flat shims
   B. Wedge-shaped shims
   C. Check for bedplate distortion
III. Demonstrate the Procedures for Setting and Leveling Machines
   A. Setting
   B. Leveling

C. Shim thickness

IMM-P2-LA
Setting and Leveling
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount pillow block bearings, shaft and coupling to a suitable bedplate; and,
   c. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.

IMM-P2-LW
Setting and Leveling
Attachment 3: **MASTER** Laboratory Worksheet

Read **"Procedure for Setting and Leveling" in the text book.**

IMM-P3-HO
Grouting
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate
II. Demonstrate Grouting Procedures
   A. Grout dam

IMM-P3-LA
Grouting
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Build a dam around the mounted unit in IMM-P2, "Setting and Leveling" practical application section; and,
   c. Grout mounted unit in IMM-P2, "Setting and Leveling" practical outline application section.

IMM-P3-LW
Grouting
Attachment 3: MASTER Laboratory Worksheet

Review grouting pages of text book.

IMM-P4-HO
Special Mountings
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe adjustable mountains; and,
b. Identify vibration isolators.

Reading Assignments:

The following chapters are assigned to read from ***Principles of Machine Operation and Maintenance***, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

Chapter	Title
3	Machinery Mounting

Module Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance
II. Identify Vibration Isolators
   A. Absorbent materials
   B. Spring mountings

IMM-P4-LA
Special Mountings
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount bedplate on adjustable mountings; and,
   c. Mount bedplate on vibration isolators.

IMM-P4-LW
Special Mountings
Attachment 3: **MASTER** Laboratory Worksheet

Review the special mountings pages in the textbook.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

1363

Duty Q

1363

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-Q1-HO
Use Electrical Test Equipment
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Reading Assignments:

The following chapters are assigned to read from *Electricity I*, Kubala, Delmar Publishing, Latest Edition:

Chapter	Title
6	Circuits

Module Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q1-LW
Use Electrical Test Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice performing.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

2. Instructor will grade student's performance on.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

IMM-Q2-HO
Apply Basic Terms to Electrical Circuits
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
g. Amperage (current);
i. Closed circuit;
j. Open circuit;
k. Sources of electricity;
l. Ohm's Law; and,
m. Power.

Reading Assignments:

The following chapters are assigned to read from *Basic Electronics*, Bernard Grab, McGraw-Hill Publishers, Latest Edition

Chapters	Title
1	Survey of Electronics
2	Electricity
3	Ohm's Law

Module Outline:

I. Polarity
II. Electron
III. Proton
IV. Neutrons
V. Coulomb
VI. Atom
VII. Voltage (Potential Difference)
VIII. Resistance
IX. Amperage (Current)
X. Closed Circuit
XI. Open Circuit
XII. Sources of Electricity
XIII. Ohm's Law
XIV. Power

IMM-Q3-HO
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Reading Assignments:

The following chapters are assigned to read from *Electrical Circuits*, Bernard Grob, McGraw-Hill Publishers, Latest Edition

Chapters	Title
3	Series Circuits
4	Parallel Circuits
5	Series-Parallel Circuits
7	Voltage Dividers
8	DC Meters

Module Outline:

I. Series Circuits
II. Parallel Circuits

III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters

IMM-Q3-LA
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q3-LW
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 3: **MASTER** Laboratory Worksheet

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1. The student will practice:
   a. Calculating series circuit;
   b. Constructing series circuit safely;
   c. Calculating parallel circuit;
   d. Constructing parallel circuit safely;
   e. Calculating series-parallel circuit;
   f. Constructing series-parallel circuit safely;
   g. Calculating AC single phase circuit; and,
   h. Constructing AC single phase circuit.

2. Instructor will grade student's performance.

IMM-Q4-HO
Check AC and DC Motors
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to install, maintain and troubleshoot:

a. Capacitor motors;
b. Repulsion motors;
c. Three phase motors;
d. Direct current motors;
e. Universal motors;
f. Shaded pole motors;
g. Generator; and,
h. Alternator.

Reading Assignments:

The following chapters are assigned to read from ***Electrical Motors,*** by Audel Publishing, Latest Edition: Use entire book as a reading assignment.

Module Outline:

I. Capacitor Motors
II. Repulsion Motors
III. Three Phase Motors
IV. Direct Current Motors
V. Universal Motors
VI. Shaded Pole Motors
VII. Generator
VIII. Alternator

IMM-Q4-LA
Check AC and DC Motors
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q4-LW
Check AC and DC Motors
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will practice installing, maintaining and troubleshooting the following motors:
   a. Capacitor motors;
   b. Repulsion motors;
   c. Three phase motors;
   d. Direct current motors;
   e. Universal motors;
   f. Shaded pole motors;
   g. Generator; and,
   h. Alternator.

2. Instructor will grade performance of student.

IMM-Q5-HO
Troubleshoot Electrical Devices
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:

a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Reading Assignments:

The following chapters are assigned to read from *Basic Electronics*, Grob, McGraw-Hill Publishers, Latest Edition:

Chapters	Title
17	Capacitance
20	Inductance

Module Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays

IMM-Q5-LA
Troubleshoot Electrical Devices
Attachment 2: **MASTER** Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-Q5-LW
Troubleshoot Electrical Devices
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice troubleshooting:
   a. Resistors;
   b. Capacitors;
   c. Inductors;
   d. Motors; and,
   e. Relays.

2. Instructor will grade students performance.

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working shift	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractions/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

1387

DUTY R

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INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-R1-HO
Force
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define force;
b. Describe linear force;
c. Describe rotational force;
d. Calculate linear force; and,
e. Calculate rotational force.

Reading Assignments:

The following chapters are assigned to read from ***Introduction to Physical Science,*** James T. Shipman, D.C. Heath Publishers, Latest Edition:

Chapters	Title
3	Force and Motion

Module Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force

IMM-R2-HO
Work
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, DC Heath Publishes, Latest Edition:

Chapters	Title
4	Work and Energy

Module Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency

IMM-R3-HO
Mechanical Motion and Rate
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define motion;
b. Define rate; and,
c. Compare motion to rate.

Reading Assignments:

The following chapters are assigned to read from *Mechanism Analysis*, Barton, Dekker Publishers, Latest Edition:

Chapter	Title
1	Types of Motion

Module Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate

IMM-R3-LA
Mechanical Motion and Rate
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate mechanical motion; and,
   c. Demonstrate how a different rate effects speeds.

IMM-R3-LW
Mechanical Motion and Rate
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will design a series of experiments to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

2. Student will be graded on his/her ability to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

IMM-R4-HO
Simple Machines
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Reading Assignments:

The following chapters are assigned to read from *Industrial Trades Handbook,* Basarnba, IPT Publishers, Latest Edition

Chapters	Title
6	Pulleys

Module Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

IMM-R4-LW
Simple Machines
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Calculate force;
   b. Properly install and adjust levers;
   c. Properly use wedges;
   d. Properly adjust cams; and,
   e. Properly install and adjust pulleys.

2. Student will be graded on:
   a. Calculating force;
   b. Properly installing and adjusting levers;
   c. Properly using wedges;
   d. Properly adjusting cams; and,
   e. Properly installing and adjusting pulleys.

IMM-R5-HO
Power
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define power;
b. Compare power to work;
c. Define mechanical power; and,
d. Compare mechanical power to electrical power.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, D. C. Heath Co. Publishers, Latest Edition

Chapter	Title
4.2	Power

Module Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout							
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Convert fractional/ decimals	B-3 Convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Perform basic geometric calculations							
C Interpret Engineering Drawings and Control Documents	C-1 Identify basic types of drawings	C-2 Identify basic layout of drawings	C-3 Review blueprint notes and dimensions										
D Use Measuring Tools	D-1 Use non-precision measuring tools	D-2 Use precision measuring tools											
E Use Hand Tools	E-1 Identify and use maintenance technician's hand tools	E-2 Identify and use hand held power tools											
F Operate Machine Tools	F-1 Use and care of milling machines	F-2 Use and care of horizontal and vertical band saws	F-3 Use and care of pedestal grinder	F-4 Use and care of surface grinder	F-5 Operate lathes	F-6 Use and care of drill press							
G Perform Welding Operations	G-1 Weld with shielded metal arc welding (SMAW) process	G-2 Weld/cut with oxyacetylene	G-3 Perform gas soldering										
H Maintain/ Troubleshoot Equipment and Systems	H-1 Maintain air conditioning systems	H-2 Maintain pneumatic control circuits	H-3 Troubleshoot centrifugal pumps	H-4 Troubleshoot positive displacement pumps	H-5 Maintain gate, globe, ball, plug, and butterfly valves	H-6 Maintain check valves and relief valves	H-7 Troubleshoot and repair blowers	H-8 Troubleshoot, maintain, and repair hydraulic systems	H-9 Troubleshoot, maintain, and repair pneumatic systems				
I Repair Power Transmission Systems	I-1 Maintain and troubleshoot belt drive systems	I-2 Maintain and troubleshoot gear power transmission drives	I-3 Maintain and troubleshoot chain power transmission drives	I-4 Maintain and troubleshoot clutches									
J Fabricate/ Install Sheet Metal Parts	J-1 Layout sheet metal parts	J-2 Form and/or bend sheet metal parts	J-3 Fasten sheet metal parts together										

INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

Duties	Tasks												
K Piping Operations	K-1 Perform basic pipefitting calculations	K-2 Cut, thread, and ream pipe	K-3 Pipe assembly	K-4 Install and adjust pipe support	K-5 Tubing	K-6 Fittings	K-7 Plastic pipe						
L Basic Rigging	L-1 Rigging fundamentals	L-2 Demonstrate basic rigging skills											
M Bearing Maintenance	M-1 Plain bearings	M-2 Rolling element bearings											
N Use Computers	N-1 Perform basic word processing	N-2 Perform basic spreadsheet operations											
O Align Shafts	O-1 Principles of alignment	O-2 Methods of alignment											
P Install/Align Machines	P-1 Install electrical connections	P-2 Setting and leveling	P-3 Grouting	P-4 Special mountings									
Q Maintain Electrical Devices	Q-1 Use electrical test equipment	Q-2 Apply basic terms to electrical circuits	Q-3 Analyze series, parallel, and complex AC/DC circuits	Q-4 Check AC and DC motors	Q-5 Troubleshoot electrical devices								
R Basic Mechanical Concepts	R-1 Force	R-2 Work	R-3 Mechanical motion and rate	R-4 Simple machines	R-5 Power								
S Fasteners and Preloading	S-1 Fasteners and nomenclature	S-2 Application for various fasteners	S-3 Techniques for removing damaged fasteners	S-4 Cleaning and restoring threaded fasteners	S-5 Torque/preload theory	S-6 Effects of lubricating threads prior to torquing	S-7 Demonstrate appropriate torquing technique						

IMM-S1-HO
Fasteners and Nomenclature
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work***, Cupples, Glencoe Publishers, Latest Edition

Chapter	Title
26	Fasteners

Module Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine

IV. Nuts
- A. Machine screw
- B. Jam

V. Washers
- A. Plain
- B. Lock
- C. Pre-assembled screw and washer

VI. Pins
- A. Cotter
- B. Tapered

VII. Keys
- A. Square
- B. Gib
- C. Woodruff

VIII. Retaining Ring
- A. Internal
- B. External

IX. Rivets
- A. Head
- B. Size
- C. Length
- D. Tinner
- E. Material
- F. Tubular
- G. Blind

X. How to Specify Fasteners
- A. Name
- B. Quanity
- C. Kind
- D. Size
- E. Shape
- F. Catalog

IMM-S1-LA
Fasteners and Nomenclature
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Identify all fasteners displayed in lab; and,
   c. Identify all tools displayed in lab.

IMM-S1-LW
Fasteners and Nomenclature
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

IMM-S2-HO
Application for Various Fasteners
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work***, Cupples, Glencoe Publishers, Latest Edition:

Chapter	Title
26	Fasteners

Module Outline:

I. Introduction
II. Bolts
  A. Head
  B. Body
III. Screws
  A. Cap
  B. Machine

IV. Nuts
- A. Machine screw
- B. Jam

V. Washers
- A. Plain
- B. Lock
- C. Pre-assemble screw and washer

VI. Pins
- A. Cotter
- B. Tapered

VII. Keys
- A. Square
- B. Gib
- C. Woodruff

VIII. Retaining Ring
- A. Internal
- B. External

IX. Rivets
- A. Head
- B. Size
- C. Length
- D. Tinner
- E. Material
- F. Tubular
- G. Blind

X. How to Specify Fasteners
- A. Name
- B. Quantity
- C. Kind
- D. Size
- E. Shape
- F. Catalog

IMM-S2-LA
Application for Various Fasteners
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to specify fasteners.

IMM-S2-LW
Application for Various Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

IMM-S3-HO
Techniques for Removing Damaged Fasteners
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to use screw extractors to remove a broken bolt.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work***, Cupples, Glencoe Publishers, Latest Edition:

Chapter	Title
25	Fasteners

Module Outline:

I. Screw Extractor Components
   A. Screw extractor
   B. Tap wrench
II. Procedure for Removing a Broken Bolt
   A. Use hand drill
   B. Deduct drill bit
   C. Secure drill bit in hand drill
   D. Drill hole in broken bolt
   E. Place tap wrench onto screw extractor
   F. Turn screw extractor counter clock wise
   G. When force to firm, stop turning and pull extract out, plus broken bolt

IMM-S3-LA
Techniques for Removing Damaged Fasteners
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will use screw extractor to remove broken bolt; and,
   c. Student will use diamond point chisel to remove broken bolt.

IMM-S3-LW
Techniques for Removing Damaged Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to use screw extractors to remove a broken bolt.

2. Student will demonstrate how to use screw extractors to remove a broken bolt.

3. Instructor will grade student's ability to use screw extractors to remove a broken bolt.

IMM-S4-HO
Cleaning and Restoring Threaded Fasteners
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Reading Assignments:

The following chapters are assigned to read from ***Metal Work,*** Cupples, Glencoe Publishers, Latest Edition:

Chapter	Title
15	Fasteners

Module Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth
II. Restoring Threads

IMM-S4-LA
Cleaning and Restoring Threaded Fasteners
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will demonstrate how to clean threaded fasteners; and,
   c. Student will demonstrate how to restore threaded fasteners.

IMM-S4-LW
Cleaning and Restoring Threaded Fasteners
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

2. Student will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

3. Instructor will grade student's ability to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

IMM-S5-HO
Torque/Preload Theory
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide***, Nelson, Audel Publishers, Latest Edition:

Chapter	Title
11	Torque Wrench

Module Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques

IMM-S6-HO
Effects of Lubricating Threads Prior to Torquing
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	Title
13	Mechanical Fasteners

Module Outline:

I. Lubrication
II. Torquing
III. Torquing Without Lubricating
IV. Lubrication Plus Torquing

IMM-S6-LA
Effects of Lubricating Threads Prior to Torquing
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
   c. Demonstrate what effects are seen by not lubricating threads prior to torquing.

IMM-S6-LW
Effects of Lubricating Threads Prior to Torquing
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how lubrication affects torquing.

2. Student will demonstrate how lubrication affects torquing.

3. Instructor will grade student's ability to demonstrate how lubrication affects torquing.

IMM-S7-HO
Demonstrate Appropriate Torquing Technique
Attachment 1: **MASTER** Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Reading Assignments:

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Nelson, Audel Publishers, Latest Edition:

Chapter	**Title**
11	Torque Wrench

Module Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing

IMM-S7-LA
Demonstrate Appropriate Torquing Technique
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate appropriate torquing technique.

IMM-S7-LW
Demonstrate Appropriate Torquing Technique
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

2. Student will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

3. Instructor will grade student's ability to:
   a. List types of torque wrenches;
   b. Select appropriate torque wrench selection;
   c. Properly use torque wrench;
   d. Properly care of torque wrench; and,
   e. Torque fasteners.